NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

A TRAINING TRANSFER STUDY OF SIMULATION GAMES

by

Ben Brown

March 2010

Thesis Advisor: William Becker
Thesis Co-Advisor: Rudolph Darken

This thesis was done at the MOVES Institute.
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REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** March 2010	**3. REPORT TYPE AND DATES COVERED** Master's Thesis

4. TITLE AND SUBTITLE A Training Transfer Study of Simulation Games	**5. FUNDING NUMBERS**
6. AUTHOR(S) Ben Brown	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A	**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB Protocol numbers:
NPS20090036-1R-EP7A-A,
NPS20090065-IR-EM3-A,
NPS20090077-IR-EM2-A

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited	**12b. DISTRIBUTION CODE** A

13. ABSTRACT (maximum 200 words)

Throughout history, military warriors have used games to accomplish training objectives. Recently, personal computer-based games have emerged as viable training platforms. In this research project, we evaluated the training effectiveness of simulation games using a particular proprietary first-person view tactical trainer called *Virtual Battlespace 2*™. Specifically, we examined squad level tactical maneuver of a combat convoy in a semi-permissive environment. We found that personal computer-based gaming was at least as effective as traditional training methods such as the sand table for preparatory tactical training. We found that trainees felt better trained after operating in the virtual environment. We also conducted an experiment to determine the extent to which the training of the simulation controller influences the effectiveness of the simulation. We found that the facilitator role can detract from a trainer's focus and that the trainer's practice and experience greatly affect the simulation training. Our findings justify the use of personal computer-based games for small unit tactical training. We conclude that personal computer-based gaming at the unit level can be a training multiplier, but the capability of the unit trainers to administer virtual training plays a large role in determining the effectiveness of the training tool.

14. SUBJECT TERMS Training Transfer, Virtual Battlespace 2, Serious Games	**15. NUMBER OF PAGES** 309
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540-01-280-5500 Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

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A TRAINING TRANSFER STUDY OF SIMULATION GAMES

Ben Brown
Major, United States Marine Corps
B.S., United States Naval Academy, 1993

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MODELING VIRTUAL ENVIRONMENTS AND SIMULATION (MOVES)

from the

NAVAL POSTGRADUATE SCHOOL
March 2010

Author: Benjamin J. Brown

Approved by: William Becker, PhD
Thesis Advisor

Rudolph Darken, PhD
Co-Advisor

Mathias Kolsch
Chairman, Modeling, Virtual Environments, and Simulation Academic Committee

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ABSTRACT

Throughout history, military warriors have used games to accomplish training objectives. Recently, personal computer-based games have emerged as viable training platforms. In this research project, we evaluated the training effectiveness of simulation games using a particular proprietary first-person view tactical trainer called *Virtual Battlespace 2*™. Specifically, we examined squad level tactical maneuver of a combat convoy in a semi-permissive environment. We found that personal computer-based gaming was at least as effective as traditional training methods such as the sand table for preparatory tactical training. We found that trainees felt better trained after operating in the virtual environment. We also conducted an experiment to determine the extent to which the training of the simulation controller influences the effectiveness of the simulation. We found that the facilitator role can detract from a trainer's focus and that the trainer's practice and experience greatly affect the simulation training. Our findings justify the use of personal computer-based games for small unit tactical training. We conclude that personal computer-based gaming at the unit level can be a training multiplier, but the capability of the unit trainers to administer virtual training plays a large role in determining the effectiveness of the training tool.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAR	After Action Review
AGTS	Advanced Gunnery Training System
ANOVA	Analysis of Variance
ARPA	Advanced Research Projects Agency
CAN	Combined Arms Network
CCM	Close Combat Marine
CCTT	Close Combat Tactical Trainer
CD-ROM	Compact Disc Read Only Memory
CNR	Combat Net Radio
COTS	Commercial Off-the-Shelf
CQB	Close Quarters Battle
CRP	Combat Readiness Percentage
DARPA	Defense Advanced Research Projects Agency
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
DVTE	Deployable Virtual Training Environment
EPME	Enlisted Professional Military Education
FAST	Fleet Anti-terrorism Security Team
FiST	Fire Support Team
FOPCSIM	Forward Observer Personal Computer Simulation
HMMWV	Highly Mobile Multi-Wheeled Vehicle
ICT	Institute for Creative Technologies
I/ITSEC	Interservice/Industry Training, Simulation, and Education Conference
ITS	Individual Training Standard
IED	Improvised Explosive Device
JSIMS	Joint Simulation System
JWARS	Joint Warfare System

LTSI	Learning Transfer System Inventory
MCAGCC	Marine Corps Air Ground Combat Center
MCMSO	Marine Corps Modeling and Simulation Office
MCO	Marine Corps Order
ModSAF	Modular Semi-Automated Forces
NAVMC	Navy and Marine Corps
MEF	Marine Expeditionary Force
MET	Mission Essential Task
MOC	Motorized Operations Course
MOVES	Modeling, Virtual Environments, and Simulation
MPS	Mission Performance Standard
MRAP	Mine Resistant Ambush Protected
NCO	Noncommissioned Officer
NPS	Naval Postgraduate School
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OPORD	Operational Order
PEO-STRI	Program Executive Office Simulation, Training, and Instrumentation Command
PM TRASYS	Program Manager Training Systems
PTSD	Posttraumatic Stress Disorder
RPG	Rocket Propelled Grenade
SINCGARS	SINgal Channel Ground and Airborne Radio System
SNAFU	Situation Normal: All Fouled Up
SOP	Standard Operating Procedure
T&R	Training and Readiness
TACOPS	Tactical Operations
TDE	Tactical Decision Exercise
TECOM	Training and Education Command
TRADOC	Training and Doctrine Command

TTECG	Tactical Training Exercise Control Group
TTP	Tactic, Technique, Procedure
VBS	Virtual Battlespace
VESL	Virtual Environments & Simulation Laboratory
VCCT	Virtual Combat Convoy Trainer
VIRTE	VIRtual Technologies and Environments
WFTBN	Weapons and Field Training Battalion

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ACKNOWLEDGMENTS

My accomplishment of this thesis project depended entirely on the support of my God for which I am truly blessed and thankful, considering the daunting challenge of the work. My family provided the best of all possible support. My wife, Tracy, patiently endured the stress of the endeavor and the all too dominating study time while my children, Joselyn and Liam, provided ample diversion when the monotony of academics became unbearable.

The projects discussed in this thesis would never have gotten off the ground without the inspiration and guiding hand of my advisor, Dr. Bill Becker. I would never have tackled a training transfer endeavor without his encouragement, and his experience was crucial to the development and execution of the experiments. Dr. Becker practiced true mentorship, allowing me the freedom to explore my own ideas, plan my own work, and choose my own destiny while providing those perfectly timed bits of guidance that made all the difference. For that, I am truly grateful. With conversations that covered every aspect of my academic experience and more, Dr. Becker provided more than just thesis advice, helping me to keep my perspective during my studies.

I am indebted to many people who made my project possible through their daily work. My fellow MOVES students not only patiently participated in some of my experiments but provided advice and support along the way. I worked with many professional Marines in fleet units, including Weapons and Field Training Battalion San Diego, 3rd Battalion 24th Marine Regiment, and Enlisted Professional Military Education Kaneohe Bay, and I appreciate their enthusiasm for my efforts. They kept this work real for me. My thesis work overlapped into several course projects done in a group environment. In this way, several students directly contributed to the background work of this thesis, including Lieutenant Sheldon Snyder USN, Lieutenant Commander Rich Morrison USN, Captain Aaron Burciaga USMC, Captain Jason Lindauer USMC, Lieutenant

Commander Heiko Abel FRG, and Lieutenant Commander Tariq Rashid USN. Finally, the Naval Postgraduate School MOVES faculty all provided support in their own way. Without the interest, input, and encouragement of people such as Commander Sullivan, Dr. Sadagic, Dr. Ciavarelli, Dr. McCauley, Dr. Darken, Professor Falby, and all the rest of the cast of characters, my project would not have been successful.

I would like to dedicate my work to the memory of Captain Alan Rowe. Captain Rowe was a native of Idaho who enlisted in the Marine Corps reserves and obtained an active duty commission as an infantry officer. He selflessly deployed time after time to Iraq in the service of his country. In 2004, Captain Rowe died from an IED blast while inspecting a bridge in his area of operations in the Anbar Province. I served as Captain Rowe's Casualty Assistance Officer, delivering the news of his death to his parents and placing his folded flag in the hands of his wife. This was, by far, the most challenging and honorable thing I have done in my Marine Corps career, and the experience drew my attention to the challenges of mobility in our operational theater. I would like to think that my work detailed in this thesis will contribute in some small way to the training efforts intended to prevent future casualties like the case of Captain Rowe. Whenever this thesis project seemed a bit too much of an effort, I reflected on the sacrifice Captain Rowe and his family made, and I worked a little harder. For this, I am thankful.

I. INTRODUCTION

A. MOTIVATION

In 2006 and 2007, I led the logistics section of a training battalion at the Marine Corps' western amphibious training base at Camp Pendleton, CA. I had just returned from combat duty in Iraq. I was in good company, because virtually every Marine in the battalion had just completed one or more combat tours. The Marine Corps used the training battalion as a resting place for deployment-weary Marines. From the Mayberry-like confines of our cantonment area, we were swept off the stage of constant deploying, training, fighting, and standing guard. Suddenly, we were watching the war the way most everyone else does. We read about the units whose ranks we once filled, and the Marines with whom we once served, as remote headlines in the newspaper or on the evening news. We no longer felt that insight of understanding the war from a first-person perspective because we were there seeing it and feeling it. Rather, we joined the millions of other people reading or hearing snippets of military action, distilled through a long journalistic chain. One did not have to read deeply or listen to too many evening news reports to gather that the face of the conflicts was ever changing, casting our experience quickly and surely into irrelevance. Within months, our experiences were merely anecdotal tidbits from a time that had come and gone; war stories to be told one day, like those of World War II or Vietnam. We had been there and done that, but we had become spectators. Worse yet, our skills declined. We were training recruits, administering the daily dither of a home-site organization. We were not fighting anyone or thinking about fighting anyone, other than through the abstractions of firing-range targets. We could feel our warfighting skills erode just as our experiences melted into memories. We were becoming irrelevant.

I had been in the command about six months when my assistant, a well-educated Captain who had joined the Marine Corps after 9-11 to serve his country, approached me with a suggestion. He couched his discussion with an overview of our waning warfighting skills and a description of the hodge-podge of logistics Marines in our section. He suggested that we go to the convoy trainer. At the time, my knowledge of the convoy trainer was limited to some vague understanding of simulation, and I had no idea where it was or who operated it. I liked the Captain's idea, though, so he and I started working on a plan when we had time, gradually forming it into some sort of executable concept.

First, we found the convoy simulator. I Marine Expeditionary Force (MEF), for all intents and purposes, encompasses all of the active duty Marines west of the Mississippi, and it is headquartered near the beach on the southern end of the base. Tucked right behind the headquarters building is the I MEF Simulation Center, a modern box of a building partitioned inside to cubicle cells of computer activity. We met with the staff there, and they showed us the convoy trainer, which turned out to be a bunch of laptop computers spread through a few different spaces. I had been in the Marine Corps long enough to know that anything new came with its own acronym soup, and soon I was lost in VBS, DVTE, and a variety of other terms. Eventually, I figured out that the convoy trainer was hosted on *Virtual Battlespace 2* (*VBS 2*™), a networked personal computer-based first-person shooter game with civilian roots. The Simulation Center staff could use simple drag-and-drop controls to build any scenario I wanted on any one of three different selections of terrain. Quickly, I saw that we had a very versatile environment with a setup that would allow all of my Marines to participate as individuals.

Through the next six months, I worked with my assistant to develop and administer a series of classes on basic convoy concepts and Tactics, Techniques, and Procedures (TTPs). We culminated the series with a detailed higher headquarters operational order to the group to conduct a convoy. We had built the exercise scenario on paper and provided the details to the Simulation Center staff for programming. We had our Marines develop different plans for conducting the mission and selected a few of the best for practice in the simulator. After all the preparation work was complete in the fall of 2007, the whole section went to the Simulation Center. The staff there gave the Marines about an hour of instruction. The first half was administrative in nature with standard Marine rules for the obvious such as keeping drinks away from the computers. The second half, about 30 minutes in length, taught the Marines how to be themselves virtually. Drivers learned to move, turn, and look with keyboard keys and gunners learned to shoot with a mouse. Finally, we had a team of virtual warfighters, complete with a plan. The Marines executed the mission once before lunch and once after with comprehensive After Action Reviews (AARs) after each run.

I left the Simulation Center with questions burning in my head. As a tank officer, I had used simulation all of my career, particularly for tank gunnery. I had used the Army's Close Combat Tactical Trainer (CCTT), where huge tank mock-ups complete with all four crew positions are networked together to fight on a virtual battlefield. However, those simulations looked and sounded like tanks, albeit with many deviations from the real thing. Our convoy exercise at the Simulation Center was different. The Marines did not see anything that day that looked remotely like a High Mobility Multi-Wheeled Vehicle (HMMWV), a machine gun, or a rifle. They saw laptop computers, and that was it. I had seen personal computers used for simulation before, but it was always through the very abstract level of operational or strategic warfighting, such as TACOPS, where map icons represent all actions. In the Simulation Center that fall day, we were not having blue rectangles meet red diamonds and wait for math to crunch through the computer to see what was left. The Marines were fighting as their individual selves, quite realistically represented in the virtual world. They had gone through two relatively elaborate exercises in less than six hours with no logistics footprint, no equipment, and no permanently established bulky simulator.

I mulled the experience over for the next few weeks, but I considered it much more thoroughly after a discussion with one of the Marine Corps' few

Simulation Officers. He explained that the Marine Corps would field VBS to all infantry battalions within a couple years. Soon, the VBS exercise I had executed with my Marines could be the norm for one-third of the Marine Corps. I looked back on my experience with alarm, recognizing that I had known very little about the simulation throughout the whole ordeal. I was not even certain the Marines had gained that much from the simulation. They benefitted from the classes a bit and certainly the planning forced them to get into a combat mindset for a moment in time. Overall, the program was better than nothing; at least they had been forced to put their minds back in a combat scenario. Had the VBS simulation contributed to making the Marines tactically better at their jobs? Or, worse, had the simulation taught them things that were not right in the real world? Certainly, we had experienced "game-isms," peculiarities associated with the simulation exercise. Did VBS really make them better? I was skeptical.

Once I reported to the Naval Postgraduate School, I started to discuss this idea with faculty and was surprised at how little knowledge existed about VBS. Most people only knew about the simulation from a cursory back-of-the-brochure sort of viewpoint, and no one had really looked into how effective the simulation was or what skill sets it best suited. The Marine Corps had already spent a lot of money on the system and had scheduled its distribution to the fleet. I became fascinated by what was known, and equally by what was not known, about the system. Finally, my thoughts and experience with VBS boiled down to a single, simple, burning question: does VBS make Marines better at their jobs? I decided to devote my two years of modeling and simulation study to this question.

B. SCOPE

I originally administered a platoon-level convoy exercise because it fit the needs of my Marines, but the proliferation of IEDs throughout OEF and OIF has brought this scenario into the public and military consciousness as never before. Figuring out how to tactically drive around has become one of the cornerstone issues of Post–9-11 military tactical thought. Moreover, this exercise focuses on the senior NCO or junior Staff NCO on whom so many important war decisions rest. Small unit tactical convoy is certainly an exercise that trains Marines in a skill set with both operational and tactical relevance.

We chose the platoon-level convoy because of its deep relevance in current operations. Convoy operations, once considered a rear echelon low-intensity combat function, have come to the forefront of military thinking in OEF and OIF. Many of the war's casualties have occurred in this area. Tactical convoys are often planned and executed at the platoon level, and platoon leadership can be required to make life and death decisions in tough situations. The operational forces have quickly ramped up convoy training since the beginning of OEF, and this aspect of simulation training deserves immediate critical scrutiny to provide the best answers for the Marines and soldiers on the ground.

The primary purpose of this thesis is to explore the effectiveness of *VBS 2*™ as a training tool for small unit tactics. Additionally, the thesis seeks to investigate whether the simulation itself contributes to increased training or if the trainer, influenced by training and experience, affects the training impact of the simulation. Information gained from exploration of the second question is intended to suggest best implementation practices for the simulation, assuming that it is shown to be effective. However, the thesis does not intend to generalize findings broadly, but rather focuses on platoon-level tactical convoy training.

C. RESEARCH QUESTIONS

This thesis focuses on the following questions:

- Does preliminary training with *VBS 2*™ positively impact performance in a squad level tactical scenario?
- Does the level of training of the simulation controller impact the effectiveness of *VBS 2*™ preliminary training?

D. METHODOLOGY

1. Background Study

We started the project by researching how other people had tackled the problem of determining whether personal computer games work for training. We conducted a literature review focusing on two major topic areas: the historical use of games for training and training transfer of simulation based training. This background research served as a starting point for the project's work.

2. Pilot Studies

We started this project with no technical knowledge of *VBS 2*™. We set up some preliminary studies to learn how to work the software and develop a basis of experience for intelligent use of the simulation as a training tool. We started by learning how to operate the simulation as a user and how to teach others to do the same. We then learned how to develop scenarios in *VBS 2*™ and tested whether they were working as designed. To see whether they worked, we first tested whether the scenarios technically performed as intended. Then we conducted testing to determine whether the scenarios met their tactical objectives.

3. Experiment in Support of Simulation Effectiveness Question

Once we had developed a sound base of experience to use *VBS 2*™ for training, we developed a set of scenarios to support training. We administered the training to an operational unit and used several methods to determine the effectiveness of the training. Methods of evaluation included surveys, performance on academic knowledge tests, and performance in live training.

4. Experiment in Support of Trainer Effect on Effectiveness Question

We developed a training program to train the trainer on the use of *VBS 2*™ to accomplish unit goals. We administered the training program and used survey and academic knowledge test evaluations to determine whether the trainer made a difference to the effectiveness of the simulation training.

5. Conclusion

We concluded the study with a series of observations and recommendations. We also described some future research that could be developed from this project.

E. CHAPTER OUTLINE

I. Introduction
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- B. Scope
- C. Research Questions
- D. Organization of the Thesis

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A. Recommendations

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II. BACKGROUND

A. INTRODUCTION

The U.S. Marine Corps encourages extracurricular reading through the "Marine Corps Professional Reading Program." This list of military related books divides its recommended titles by rank so that each Marine reads material correctly related to the level of warfare typical of his or her pay grade. For the most part, these titles take Marines back into the history of warfare or military heritage. They may provide doctrinal insights or relate different views of tactics, techniques, and procedures. One book recommended for entry-level Marines at both the officer and enlisted levels stands out because it simply does not fit with these other works. The book is a science fiction novel from the mid-1980s called *Ender's Game* (U.S. Marine Corps, n.d.).

Orson Scott Card published *Ender's Game* in 1985, when computers were not quite established in every household and the Cold War still defined the American understanding of what war was and what a military did. The novel's protagonist, Ender, was a 12-year-old boy who played video games well. He did so well, in fact, that the government sent him to Battle School for advanced training. While at Battle School, he learned all the known techniques of playing the school's games and became the best at them all. The government developed Battle School to immerse students in the gaming environment in preparation for armed conflict with the buggers, an insect-like alien race that threatened to overwhelm Earth. Ender excelled in this environment, taking on increasingly more difficult simulations. Finally, Ender fought in a culminating, enormously challenging computer game. Feeling his options close in after a particularly overwhelming series of actions, Ender made a risky move in the game and consequently won the day. Exhausted, he left the simulator to find out the secret of the game and of Battle School itself. His mentor and instructor explained:

> Ender, for the past few months you have been the battle commander of our fleets. This was the Third Invasion. There were no games, the battles were real, and the only enemy you fought was the buggers. (p. 296)

Ender, in fact, had been remotely controlling a fleet of ships fighting the real buggers. Some of his old friends from Battle School had been piloting the ships under his command (Card, 1985).

This thesis is about simulation, so the idea of including a book in the Professional Reading Program whose theme espouses such a triumph of simulation is most intriguing. However, *Ender's Game* offers more as a reading list recommendation than this. The Marine Corps most likely included this book as an illustration of the close, and sometimes indistinguishable, relationship between training and war. The idea of Ender unwittingly controlling a living, breathing, and dying army while playing a video game is novel and thought-provoking. He was training for war. Ultimately, every commander yearns for this level of training in any given scenario. That is, the training should be so real that one cannot tell the difference from actual combat. The military should seek this level of training in all endeavors, so that servicemembers execute in exactly the same way during peace or war with the state of hostilities being irrelevant.

Michael Macedonia, the technology officer for Program Executive Office Simulation, Training, and Instrumentation Command (PEO STRI), looked at the inseparability between training and the reality of war another way. He hailed a scene from the movie *Patton* as illustrative of his point. In the scene, General Patton approached an open area while directing his driver to a battle scene. He described to his driver a scene of ancient battle between the Carthaginians and the Romans far removed from the movie's World War II engagements. Then, Patton said, "I was here." Macedonia pointed out that the scene painted a picture of a man so engrossed in the study of war history that events of his studies became their own reality in the general's mind. General Patton's literary education created memories in his mind that were not there before. Macedonia explained that simulation boils down to the ultimate objective of creating memories. Soldiers and Marines on the battlefield against a fighting enemy should look at their situation and recognize that they were there, that they have seen this before (Halter, 2006). In this way, Macedonia sets the bar for simulation, games, and training. An individual who has used the training tool should approach the real event knowing its subtleties and nuances from thorough exploration with the tool. Like Ender, the soldier or Marine should participate at such a level that the fact of a real adversary becomes immaterial; the skills and their application are the same.

This thesis invites exploration into two general domains. First, military games have a rich history and that history must hold some nuggets of truth about what games can and cannot do for the warfighter. Second, concern over the effectiveness of simulation is not a new topic. Studies wrestling with such questions are typically lumped under the umbrella of "training transfer." A review of past training transfer efforts should shed some light on the Best Practices for evaluating simulation training systems.

B. EVOLUTION OF PERSONAL COMPUTER-BASED TRAINING GAMES

Humans have a history of playing games of the mind and of the body that seems as old and as diverse as any other activity. Today, an array of bright, shiny, new objects stands before the services as the cutting edge, innovative training of the future. Personal computer-based simulations are these objects, and they have gained attention, both skeptical and enthusiastic. Some researchers have called this genre of training device "serious games," to thwart the idea that our troops are going to the arcade to learn to fight. One might question just how new and innovative this idea really is.

1. Games Have Been Around a Long Time – Just Like War

The story has it that the father of a young Indian prince died before he could teach his son the skills, tactics, and strategies of war. The prince's advisors fretted over how to prepare the prince for battle with known adversaries that imminently threatened the kingdom. At a loss for a better training mechanism, the advisors introduced the young prince to chess, a game that he played regularly. Later, after a victorious rout on the field of battle, the prince attributed his success to the development of his mind with the chessboard (Forbes, 1860). The story is a mere anecdote, certainly of questionable value as historic fact. However, the idea that someone thought up the story illustrates the long-standing close link between games and war. The origins of chess provide grounds for debate, but the game clearly has roots in an Indian game called *Chaturanga*. In that game, the pieces were modeled after the battlefield assets of the day, such as elephant and horse, and two players took turns moving about a gridded square according to movement rules similar to chess (Caffrey, 2000). One simply cannot ignore these martial roots.

A strategy game called *Wei Ch'I*, or, in popular western parlance, *Go*, is hailed as the oldest strategy game still played in its original state. Archaeological evidence points to ancient Chinese origins. The game of Go spread across the entire Orient and is still played. Legend suggests that the game has military origins. Encirclement is a fundamental feature of the game, and the ancient Chinese used this strategy of dominance both in hunting and warring tactics. Go is notable for many reasons. The game was extremely widespread and enjoyed a long history that still lives on. Go has been recognized as a domain of the elite, and proficiency in Go has been a criterion for the elite in China, Japan, and other Asian countries. In fact, Japan formalized Go as a fundamental part of the Shogun's court in the medieval period. Most importantly, Go influenced many aspects of life in Asia including religion, philosophy, politics, and war. Go is often linked with the yin and yang of Taoism. Go influenced such thinkers as Sun Tzu, the author *The Art of War*, the oldest military doctrine, which is a book that serves players of Go as well as warfighters. Mao Tse-tung reputedly used Go in the development of his military and political theories. Go's importance stems from its widespread impact on a whole society throughout history, not only as a pastime, but as a way of thinking about life and applying those ideas practically (Shotwell, 2003).

These games from ancient history tell us very little about how to use a game to train a military fighting man today. The depth of the history, however, indicates that games have been used to develop and influence military strategy far back into the beginnings of war itself. The idea of abstracting the concepts of war into a game, with systems of rules and randomization that individuals can play out against other minds, is not new in any way. Techniques have matured over the years, as the next sections will show, but the theme of gaming for military benefit has deep roots. One can trace the games just discussed back to the fifth century BC. The serious game is a new term, but it is not a new idea.

2. Games Do Not Have to Be Limited to Strategic-Level Abstractions

Gaming for training began to evolve beyond the confines of the chessboard in the mid-1600s. In England, the King's Game was used as a training device. With thirty pieces to a side and a more robust rule set than chess, the game added realism beyond chess. Meanwhile, the French used card games to train military professionals. These games featured actual engagement situations, thereby extending realism beyond the chessboard. The Prussians also used games for training, relying on the math and geometry of the game to replicate war as a science (Brewer & Shubik, 1979). In fact, it was a Prussian named Baron von Reisswitz who is credited with fathering modern wargaming.

The Germans coined the term *kriegsspiel,* translated "wargame" in English. No thesis written by a Marine would be complete without a tribute to a dead German, and this one will be no different. Baron von Reisswitz served the state of Prussia as the war counselor at Breslau. In 1811, he introduced a training concept that has changed very little over time, considering the technological breakthroughs of the two centuries since then. Officials moderated a game played on a table with actual terrain modeled on top. Units represented by blocks moved across the table in response to orders from the players. The moderating officials received the orders from the players and updated the table accordingly. In order to adjudicate battlefield effects, they used tables to calculate attrition based on factors such as range and terrain. The game was not deterministic though, because the final outcome faced the uncertainty of a dice throw. Many of the advanced and highly used simulations of today owe their conceptual design to this early innovation, with the only significant difference being the added computational power of modern computers. Nevertheless, for all of the evidence of Reisswitz's contributions in today's war simulations, Reisswitz did not revolutionize warfare, battlefield planning, or combat training in 1811. Kriegsspiel merely served as an amusement for the elite, never to be used by the fighting forces on the ground. Baron von Reisswitz's son brought kriegsspiel to the common fighting man when he altered the game so that players could use a map, making the game much more portable. In 1824, the Prussian chief of staff General Karl von Muffling liked the idea so much that he ordered all garrisons to use it (Caffrey, 2000).

In 1837, General von Moltke took the ideas of Baron von Reisswitz and his son and turned them into a bona fide training regime. He incorporated wargaming with staff rides to train the officer corps of the Prussian army. As the Prussians demonstrated prowess on the early nineteenth century battlefield, the other nations of the world took notice and started using wargames of their own. Spenser Wilkinson, a British college student vacationing in Germany in 1873, exemplified this world attention. After noticing Britain's numerical inferiority to the rest of Europe in a pamphlet, he returned to England and organized the country's first wargaming club. In the United States, Major Livermore started copying German wargames in 1883. He improved the Germans' attrition tables with updated statistics from the American Civil War. The U.S. Army's Chief of Staff, General William T. Sherman, disapproved of the wargame because, in the game, units fought to the last man, something experience had proven unrealistic. About the same time, William McCarty Little fathered naval wargaming in America. A key player in the formation of the Naval War College, McCarty Little instituted wargaming there in 1889, where wargames have occurred every year since. The Army followed this practice in its own war college starting in 1899 (Caffrey, 2000).

Wargaming demonstrated both its power and its shortcomings in the preparations for World War I. Both the Germans and the British analyzed Count Alfred von Schlieffen's invasion plans, and both governments used wargame results to make national decisions about military preparation. However, the German wargaming, meticulous and calculated as it was, failed to anticipate diplomatic and political consequences that were seen in their defeat. While most of the nations who participated in World War II used wargaming in the inter-war years, the Navy and Marine Corps had the champion effort. The Navy developed the island-hopping theory that would eventually become the backbone of the Pacific campaign, while the Marine Corps changed the face of amphibious doctrine through wargames in lieu of a budget for live amphibious training. By far, the most significant wargamed event of this time was the Japanese attack on Pearl Harbor, where wargaming radically changed the original plan, producing the intended results. All major players in World War II used wargaming to some extent, such that wargaming was an accepted military practice by the end of the conflict (Caffrey, 2000).

Reisswitz brought us the red and blue of war. He color-coded his original nineteenth century tokens this way, setting a standard for military lingo today. More than just colors, Reisswitz introduced a way of visualizing the battlefield and its infinite layers of possibilities. Unlike the strategic games of Go, chess, and patteia that were played at the strategic level in the homes of the elite, Reisswitz's style of wargaming influenced the warfighter himself at the operational level of war. As military actions such as Pearl Harbor illustrated, wargaming had much more power than providing a theoretical forum for abstract concepts: wargaming started to change war itself, as militaries instituted it as a standard battle preparation activity.

3. Wargaming Links the Living Room and the Command Post

"A gun capable of hitting a toy soldier nine times out of ten at a distance of nine yards" sounds like the perfect Christmas gift for a young boy. This quote comes from the exuberant text of H. G. Wells' 1913 wargaming manual *Little wars*. Wells was not excited about this toy gun for his children; rather, he was using the toy along with paper houses, miniature trees, and toy soldiers to build his own battlefields on his lawn or living room floor. The roots of Wells' work started with "lunching with a friend" and evolved into a sophisticated explanation of how to model war in one's home, complete with a full example battle (Wells, 1970). Robert Louis Stevenson is another notable author who engaged in war games, devoting much of a three-year convalescent period to the development of a detailed war. Sir Winston Churchill's childhood war games with his brother, Jack, influenced his decision to join the military. Churchill never lost his love of playing with toy soldiers, taking the hobby into his adult years (Featherstone, 1962).

Toy soldiers emerged in European culture on the heels of Reisswitz's wargame. Daddy played with lead figurines to re-enact history or to learn the best tactics, and Junior wanted a piece of the action. War made great toys, and World War I sparked its own set of miniature replicas of machines of destruction. In fact, toy soldiers grew into an industry to satisfy both youth and adults. This play has never gone away. From plastic "army men" to the GI Joe action figures, youth have delighted in toys that depict war. H. G. Wells captures it all in his subtitle to *Little wars*: "A game for boys from twelve years of age to one hundred and fifty and for that more intelligent sort of girl who likes boys' games and books." Many people want to be the general, if only for a moment, whether it be the boy in his room, the adult hobbyist at his couch, or the actual general himself making plans to defeat the enemy (Featherstone, 1962). This fundamental inseparability between the living room and the war room contributes to understanding the strengths and weaknesses of the twenty-first century serious games.

4. A Soldier Can Interface With an Electronic Device to Train

In the 1930s, Edwin Link did not have money for a plane to learn to fly, so he developed a plan to help people learn to fly without an actual aircraft. He built a simulator. His wooden box mounted on a crude motion platform did not look much like its modern successors of today, but it provided enough realism for people to learn the basics of aviation, particularly in the area of instrument flight. Link's work might have gone largely unnoticed if an unfortunate series of Army Air Corps accidents had not attracted attention to flight training. In 1934, Link amazed Army officers by safely landing his plane out of a cloudy sky by flying completely on instruments. The Army Air Corps contracted with Link to build simulators for the military so that pilots could learn instrument flying. Link's trainer contained a mock instrument panel and the basic plane controls. With these tools, students could learn to fly without looking at the ground. Link's company produced over 10,000 of his "Blue Boxes" during World War II, and simulation became a staple of military pilot training (*L3 Communications, 2010*).

Link's trainer has very little to do with gaming itself, but it is relevant to this study because of its introduction of the virtual world. Until the twentieth century, training at the soldier level involved learning basic skill sets, such as operation of a firearm or short scripted movements in the form of battle drills. World War I changed all that with complicated machinery, like the tank, machine gun, and airplane; equipment that could influence the battlefield like never before. Suddenly, an individual soldier's relationship to a particular machine mattered. The idea that the military needed to train this relationship at all was novel, and Link's idea of doing so through simulation was truly ahead of his time. Though crude, Link's trainer, through its instruments and motions, provided the trainee a visualization of a world that did not exist. Link invented the virtual world, before the computer made such things commonplace. It is worth noting that the first virtual world was developed for military training.

5. The Computer Adds New Possibilities for Wargaming

After World War II, concern over how to fight a nuclear war gave wargaming a new boost, since this was the only venue available to analyze nuclear tactics and strategy. During the 1950s, the Air Force led the Department of Defense to work with RAND Corporation to develop wargaming as a complex mathematical exercise. RAND created some ideas that stuck, such as the gridded playing board, tables to calculate the results of combat actions mathematically, randomization through dice, rules for playing by turns, and the incorporation of terrain. Charles Roberts conducted a parallel game development effort that led to the creation of the commercial entertainment company Avalon Hill, in 1958. RAND brought mathematical gaming to the military, and Avalon Hill took it to the living room (Smith, 2008). Through the 1950s and 1960s, this mathematically based style of military wargaming matured. Most notably, though, wargaming remained mainly at the strategic or operational levels, with games oriented on winning by destroying more personnel and materiel than the other players destroyed. There was some recognition that wargaming needed to extend beyond attrition. For example, a 1964 Advanced Research Projects Agency (ARPA) project sought a wargame that would demonstrate political, economic, and psychological aspects of an insurgency, but the research efforts did not go very far in changing the face of attrition gaming (Caffrey, 2000). Such wargaming efforts continued to mature throughout the 1970s, in both military and civilian sectors. While military and civilian gaming remained largely separate efforts, it would be a mistake to discount any relationship between the two. For example, in 1974, the Army purchased a commercial wargame called *Fire Fight* to supplement its wargaming collection (Caffrey, 2000).

These mathematical models of war increased in accuracy as the math increased in complexity. Eventually, computers broke the mold for wargaming. At first, computers served only as glorified calculators, but even this advance allowed wargaming complexity to develop. The mechanics of game play remained the same with playing boards, lookup tables, representational pieces, and dice, but computers sped up the calculations allowing more precise numerical modeling. During the 1970s and 1980s, the wargame moved from the playing board to the computer itself as computers grew powerful enough for the job. Eventually, computers supported gaming well enough to offer advantages never fathomed in the days of the playing board. Players could work in separate rooms with customized views. They could make decisions and implement them in real time with many others doing the same. The age of the computer game had begun. Because computers were still too expensive and bulky for the average consumer, these games stayed military. The games' roots in strategic and operational board gaming kept simulation at the higher levels of war.

Wargaming and war modeling became integral components of training and planning during the 1990s. The rise of the personal computer made simulations such as JANUS and Modular Semi-Automated Forces (ModSAF) widespread. Simulations like these proved themselves during the planning and execution of the Gulf War (Smith, 2008). All services used such games in training throughout the 1990s, and many joint efforts brought the services together in simulated environments. The 1991 creation of the Defense Modeling and Simulation Office (DMSO) demonstrated the importance of the community, and simulations such as the Joint Simulation System (JSIMS) and the Joint Warfare System (JWARS) showed efforts to bring everyone together in the joint arena (Caffrey, 2000).

6. The Military Can Train Cheaply Through Adaptation of Civilian Games

In 1995, General Krulak, the U.S. Marine Corps Commandant at the time, issued his Planning Guidance that provided the broad vision for the service for the next four years. The following directive ranked third-highest in the priority list: “Make our education and training processes and institutions technologically innovative, challenging, and fun” (Jernigan, 1997). General Krulak even added teeth to this task with the creation of the Marine Warfighting Lab to test new strategies, technologies, and ideas. The Commandant’s Planning Guidance opened new horizons for Quantico’s Marine Corps Modeling and Simulation Office (MCMSO). A couple of Marines searched all available civilian gaming systems to find anything useful for military training. As a marketing ploy, id Software had released parts of *Doom II* as shareware for players to modify. Seizing the opportunity, Sergeant Daniel Snyder spent three months of his off-duty time changing *Doom II* into *Marine Doom*, an application with military avatars, M16 rifles, and realistic survival rates (Jernigan, 1997). As many as four players could fight each other in a two-dimensional urban environment of walls and passageways. For the price of a $49.95 *Doom II* CD-ROM, the Marine Corps had built a simulation capable of teaching individual and fire team skills. Since the game resided on a CD-ROM, Marines could use it on any computer, playing the game at their desks or taking it on deployment wherever the Corps might send them (Riddell, 1997).

Marine Doom did not come into the Corps as just a fly-by-night affair. While the program owed its existence to the innovation of fewer than a handful of Marines, the project reflected imagination, analysis, and forward thinking. Merely gaining acceptance of any such game was a Sisyphean task. Ironically, Sergeant Snyder had installed *Doom* on the hard drive of his computer a few years earlier in communications school. In doing so, he had violated a Marine Corps order prohibiting computer games on military hard drives and received nonjudicial punishment for his actions. In 1995, General Krulak’s guidance changed everything, and *Marine Doom's* prospects looked bright with the full support of the Commandant. Sergeant Snyder and his Officer in Charge, Lieutenant Scott Barnett, had developed a training system that met Marine Corps training objectives of interlocking fields of fire, use of cover and concealment, and effective communications (Riddell, 1997). *Marine Doom* joined a small list of twelve simulations allowed on Marine computers (Jernigan, 1997). For the next few years, Marines fought each other in their offices during lunch breaks. The program slowly slid into extinction as better technologies developed. Game problems, such as player tunnel vision, unrepresented firing positions, and weapons that never overheated, came to the surface (Jernigan, 1997). *Marine Doom* only featured a two-dimensional battle space, a particularly limiting problem when simulating urban combat. Lurking in the background of this early experiment was the haunting question of how much good such technology could do and, worse, whether it could do harm by teaching players the wrong techniques. With such a rags-to-riches start, eventually gaining the enthusiastic support of the Commandant himself, *Marine Doom* soared to great heights as a training platform, but faded into obscurity almost as rapidly. In the end, commanders did not see the training results. Two Marines had successfully leveraged commercial off-the-shelf (COTS) technology, but the training simply did not transfer to the warfighter. The game disappeared. The ground had been broken, however; civilian computer gaming technology could be levied for military use.

General Krulak's guidance, coupled with Sergeant Snyder's proactive execution, had demonstrated the potential for using the shelves of the local computer store for military training, but Sergeant Snyder was not the first to use this technique. In 1980, Atari introduced the first-person shooter game with *Battlezone*. This early video game allowed a player to act as a tank gunner and engage enemy tanks on a three-dimensional battlefield. The player looked through a small viewfinder window and manipulated controls like those in a real tank. Users could prowl around a virtual world, albeit one composed of the sparse graphics of the time, complete with three-dimensional terrain. *Battlezone* simplified the battlefield into sterile tank on tank battles with no people, just tanks that either lived or died. Nevertheless, players immersed themselves in the soldier's battlefield for the first time, fighting from the arcade just like a soldier in a real tank (Halter, 2006).

The Army recognized the potential for the addictive game play to turn a leisure activity into valuable training. The service persuaded Ed Rotberg, Atari's *Battlezone* designer, to transform the game into a military training device. After three months of long hours and hard work, Rotberg produced *Army Battlezone*. General Donn A. Starry was the commanding general of TRADOC at the time, and he oversaw Atari's project. General Starry recognized that soldiers had grown up in an environment of electronic gadgetry, and teaching methods for this new breed had to be developed accordingly. In a 1981 conference, he asked a question that is still quite relevant:

> In an era that has seen such fantastic technological achievements, how is it that our soldiers are still sitting in classrooms, still listening to lectures, still depending on books and other paper reading materials, when possibly new and better means for training have been available for many years? (Halter, 2006)

General Starry had introduced the training concept that General Krulak worked so hard to put into practice fifteen years later. The products in the teenager's arcade were fair game for military training, if only the military applied the right imagination and planning.

7. Games Can Benefit the Individual Warfighter

While the wargaming discussed thus far impacted strategy for centuries, this type of gaming does nothing for the individual warfighter. The soldier or Marine on the ground needs something at the tactical level. Before computers, the Tactical Decision Exercise (TDE) accomplished this objective. A TDE poses a static military situation to the participant in the form of a simple sketch or composite of map graphics. The participant individually develops a solution for the situation, usually in a limited amount of time, and prepares the orders that he or she would give subordinates to execute his or her plan. TDEs orient on an individual's decision-making ability. Rarely is the plan itself the point of the exercise; most often, the rationale that led to the plan produces the real learning. TDEs offer teaching power by pitting the mind of the participant against the experience of a mentor or instructor. Certainly, the TDE provides a forum to discuss tactics, techniques, and procedures in a practical application. More than that, TDEs provide a window into the mentor's mind, allowing the student to see how to work through a problem or to see how the mentor thinks. In this way, TDEs provide a mechanism to convey commander's intent and battlefield vision. Like the board games previously discussed, computers take TDEs to new levels. Virtual worlds allow participants to see their plans through a simulated execution. As Major Brewster puts it in his 2002 article on the subject, "Simulation allows the student to progress to the point where he can observe the ramifications of his decisions" (Brewster, 2002). An understanding of TDEs is crucial to harnessing the power of personal computer-based games.

The Marine Corps uses a simulation called *Close Combat Marine* (CCM) to stimulate decision making at the junior leadership level. The simulation provides a simplistic two-dimensional map interface for multiple players to manipulate units, usually at the squad level. Using the map, a trainer can develop a scenario, and Marines can maneuver forces and watch the results of their decisions. Quite simply, CCM is a natural computer extension of the TDE. In 2007, two officers at the Naval Postgraduate School conducted a study to determine whether CCM introduced any training advantage over the more traditional TDE. They found that both training media provided benefit, but that only the computer simulation provided a means to evaluate situational awareness (Fitzpatrick III & Ayvaz, 2007). Because of the importance of situational awareness in team leadership and decision making, this finding indicated that computer games offered the individual soldier or Marine something that could not be obtained with just paper, pencil, and tokens on a table.

A simplified version of kriegsspiel has provided a training medium for the individual soldier or Marine for years. Sand table exercises involve the use of small replicas of battlefield forces on a model of the terrain to demonstrate, analyze, or practice tactical maneuver and fires. While this sort of gaming has a rich history and can become quite complex, implementations at the small unit level are usually quite simple. The terrain model might be a ruffled-up bed cover in a barracks room, a dirt patch in a common area outside, or an actual table top with sides holding a sand box that easily models hills and valleys. Force replicas might be simple toy military men and vehicles, miniature vehicle replicas, or rocks available on the ground. Typically, trainees practice a scenario by timeframe, with each key player describing actions he would take at prescribed times and locations. A controller can then assess the effects of the actions to determine how the succeeding timeframe will begin. In a study involving a comparison of the sand table exercise and other traditional training with computer-based games, Majors Nolan and Jones noted that some participants preferred the sand table to simulation because the sand tables "help lowest level operators get a big picture view" (Nolan & Jones, 2005).

Small units may practice a tactical scenario by using a field or large common area in garrison for a physical walk-through of the exercise. The trainer uses markers on the ground to replicate the terrain from the scenario. Trainees then walk along the replicated routes to each point in the scenario, briefing their actions as they would around the sand table. Such exercises provide individuals the opportunity to visualize what is happening around them in the context of the scenario. Such exercises, therefore, provide a valuable opportunity to synchronize actions and provide all participants with a common view of the big picture.

Returning the focus to computers, the gaming landscape changed for the individual warfighter in the past decade, but the military did not provoke it. Modern personal computers became powerful enough that the resulting civilian gaming market produced software that rivaled anything seen in the defense arena. This brings the discussion back to 1995, to Sergeant Snyder and Marine Doom. While Sergeant Snyder's project broke new ground, personal computer-based games did not become the training venue of choice in the late 1990s. Military culture still looked at gaming as a hobby or recreation rather than something to consider as a serious training aid. That culture began to erode as the profile of computer experience for the individual warfighter himself changed. By 2005, a reporter noted the prevalence of gaming in Iraq. Games such as *Half Life 2* and *Halo* competed for storage space in the little deployment libraries reserved for books and movies (Associated Press, 2005). The handwriting was on the wall: gaming was a part of life for troops. The only issue was whether the military could glean training value from it.

Michael Macedonia, a former Chief Technology Officer for PEO-STRI, has written about the change in military culture that has made computer gaming an acceptable concept. Using the catch phrase "wired generation," Macedonia pointed out that the pool of young people currently filling the ranks of the military has always known computer games. He summarized some U.S. Army studies by highlighting the following differences in the wired generation's skills and attitudes:

- Multiprocessing, the ability to perform several tasks (such as listen to music, talk on a cell phone, and use the computer) concurrently
- Attention span variation in a manner similar to senior executives exhibiting fast context switching
- Information navigation changes that define literacy not only as text but also as images and multimedia
- Shift in focus of learning from passive listening to discovery-based experiential and example-based learning
- Shift in type of reasoning from deductive and abstract to the concrete

- Intelligence organized in easily accessible databases
- Community of practice emerging from sharing tasks involving both tacit and explicit knowledge over a substantial period of time." (Macedonia, 2005).

Introduction of a loose term is necessary for the remaining discussion. Most people have a certain mental image when they hear the term "computer game." Generally, most people imagine something played on a personal computer or similar device, such as XBox. This concept has broadened to include games that can be networked through wire connections between computers or across the Internet. At the extreme, massively multiplayer games stretch across the broad expanses of the Internet, encompassing thousands of users. For the most part, these games are leisure activities both in design and in use. The military uses games that fit into this general category for training or analysis. To distinguish computer gaming with an actual military purpose, Ben Sawyer, a high-tech freelance writer and technology consultant, coined the term "serious games," and the term has caught on (Macedonia, 2005). For sake of convenience, this thesis incorporates the various sorts of personal computer-based military games under this umbrella. Serious games are based on personal computers, whether networked or not. They are games in which participants are actively engaged in a thinking contest against other participants or against the computer algorithms of the game. They are serious in that they are intended to have military value. For the purposes of this thesis, serious games have value for the direct user; in other words, the trainee himself sits at the computer and interacts with the game.

Serious games can contribute to the military. Two Canadian researchers summarized potential uses for serious games in a paper prepared for the 2008 Interservice / Industry Training, Simulation, and Education Conference:

- Introducing, teaching, and rehearsing new drills;
- Showing both enemy and friendly viewpoints;

- Representing the use and effects of future systems not yet available for conventional training;
- Reviewing actions and events from different perspectives in post game analysis, after action review; and teambuilding (Roman & Brown, 2008).

The authors further pointed out that serious games train cognitive skills but not psycho-motor skills. More importantly, the use of serious games is not just some theoretical proposal of the academics. Quite the contrary, serious games are already out there, and science is catching up to see what operators are doing with them.

If serious games provide any benefit at all, their price tags attract immediate attention. Serious games are cheap, particularly if the civilian market bears a parallel research and development burden. The past decade has seen quite a bit of Department of Defense acquisition reform aimed at minimizing the massive, stove-piped, counterproductive Pentagon buying methods. Contractors with broad system goals design and produce, cutting costs where they see fit to produce the best product. Serious gaming provides the perfect arena for this type of acquisition. Civilian contractors often have experience in designing the type of software the military needs. The project simply becomes an adaptation of existing ideas to military requirements (Robinson, 1998). One of the first modern large-scale efforts toward adapting a civilian game to military needs was Mak Technologies' modification of *Spearhead* in the late 1990s. Warren Katz, the chief executive officer, warned against oversimplifying the civilian game adaptation process:

> Many people think you can take a video game out of a box and just use it for training or think the modifications are small. The modifications are fairly sophisticated. Making a video game HLA-compliant is no easy task. (Erwin, 2000)

Nevertheless, the cost of the development of serious games pales in comparison to large-scale simulations, and operational costs are virtually negligible compared to those associated with large simulations or field training. Katz compared "expensive dome-based simulators with a motion base and full wrap-around imagery," that cost $5,000 to $10,000 per hour to operate, to a personal computer-based game that costs 25 cents per hour (Erwin, 2000). Clearly, money talks when it comes to serious games.

In 2004, with Operation Iraqi Freedom stealing the spotlight of military money and thought, the Defense Advanced Research Projects Agency (DARPA) fielded *DARWARS Ambush!* to operational units in Iraq within six months of learning of a motorized ambush training shortfall. In the attempt to use gaming technology to mitigate the damage to operational forces from ambush, DARPA built a tactical application on a civilian computer game called *Operation Flashpoint* (Peck, 2004). The game allowed soldiers to author their own scenarios on the fly. Soon, the Army used the simulation both in theater and stateside to enhance training. Additionally, personnel began to experiment with using the serious game for rehearsal with soldiers at Fort Polk, providing virtual tours of the places where troops would fight weeks later (Laurent, 2007). The project illustrated that not only could serious games provide training tools cheaply, but they could do it quickly. Just as important, soldiers liked the training and adapted to it readily. Roger Smith, the Chief Technology Officer for PEO-STRI, described soldiers using *DARWARS Ambush!*:

> The soldiers just dive in and start 'playing' the scenarios. Then they start adapting those scenarios to make them more realistic. They are not only learning the given scenarios, but teaching themselves to replicate real-life experiences to re-live and recreate what they've seen on their own missions. (McLeroy, 2008)

A 1996 conference, that brought the military, research, entertainment, and gaming communities together, spawned the creation of a modern-day RAND Corporation of sorts. The Institute for Creative Technologies (ICT) was initiated at the University of Southern California, in 1999, to pool the best ideas of all the communities into collaborative projects for the benefit of all. That same year, Michael Macedonia of PEO STRI proposed the development of a console-based training system for the soldier on the ground. Five years later, ICT produced *Full Spectrum Warrior*. The game's title references the *Joint Vision 2020* concept of full-spectrum dominance, whereby military forces control situations ranging from relatively peaceful security operations to the worst of the nuclear threats. The game allows players to manipulate a squad through urban settings to destroy a variety of enemy. *Full Spectrum Warrior* demonstrates the type of partnership that serious games entail. The Army got a simulation, but the entertainment industry got a top-selling blockbuster when the civilian version hit the shelves of local stores. *Full Spectrum Warrior* has become a hit in the military, where it is even being considered for such nontraditional uses as re-creating traumatic contextual stimuli for treatment of PTSD patients (Halter, 2006).

The final synthesis of leisure and war training occurred with America's Army, a game to get civilians interested in joining the Army. The Army sought to capitalize on the relationship between the armchair teenage general and the individual soldier through the development of America's Army. Touted as a recruiting tool, the concept of America's Army extended well beyond luring youth to the recruiting office. The Army envisioned a tool that would attract the wired generation to the military through leisure activity. Then, the Army would use that same leisure activity to train the newly recruited soldiers on the job. Conceivably, a young man would play on America's Army the week before his prom and train on the same platform months later in preparation for combat. America's Army is unique in that it was developed completely inside the Department of Defense at the Naval Postgraduate School's Modeling, Virtual Environments, and Simulation (MOVES) Institute. America's Army introduced a new idea to the military training arena: gaming as a recruiting tool. It also represented the first government production of a video game in the public domain (Li, 2003). Traditionally, the first training a soldier or Marine saw was marching, shooting, running, and the discipline of a platoon sergeant. Now, the first training a soldier might see could be a serious game. The wargame had potentially gone from the pastime of a bored aristocrat to the initiating element in a soldier's warfighting career.

Serious games offer another benefit to the military constantly on the go: deployability. The Marine Corps developed a program called Deployable Virtual Training Environment (DVTE) that combined a variety of personal computer-based simulations onto a single laptop. Suites of thirty of these laptops are being fielded to each infantry battalion in the active and reserve Marine Corps. The initiative turned simulation into something that extended beyond the physical bounds of a camp simulation center and beyond the reach of a technical contractor. DVTE will be readily available to all infantry units in their own training shops. With a moderately small number of computer cases, a deploying battalion can pack an entire simulation center along for the trip (Figure 1). Units can transform static forward operating bases and ship berthing into active training domains for the otherwise bored Marine. DVTE makes training available anywhere at any time.

Figure 1. DVTE case for four computers and associated equipment

8. The Military Does Not Know Whether Serious Games Work

This thesis has presented a series of serious games currently used by the military in the effort to demonstrate the proliferation of gaming technology in today's forces. Examination of these examples shows that the games have come into use primarily because they are cheap, readily available, portable, and have incredible potential for training, rehearsal, and analysis. Most serious games are used because commanders instinctively recognized their potential and started using them. This process contrasts with the acquisition of most military systems in which the Department of Defense and contractors go through years of iterative design, testing, and evaluation before fielding a product. A critical review of Ed Halter's review of serious games for military applications, entitled *From Sun Tzu to Xbox,* summed up the resulting problem well: "There just isn't any evidence that any of it [serious gaming efforts in general] works, and Halter doesn't even bother trying to prove otherwise" (Klein, 2006). This comment seems to extend beyond Ed Halter; little research has been done to determine the effectiveness of serious games. Consequently, these serious games are being used for serious purposes without a scientific background demonstrating their effectiveness.

Consider the case of *Marine Doom*. Sergeant Snyder produced the game in the attempt to leverage technology for the benefit of the fighting Marine. While the game fulfilled stated training objectives, no one measured whether those objectives were truly met, and the game's short-lived tenure casts doubt that they were. *DARWARS Ambush!* was produced and fielded within six months. Clearly, that time was spent on development rather than analysis of effectiveness. Even more fully supported programs like Full Spectrum Warrior and America's Army have borne little scientific scrutiny into their effectiveness as training platforms.

Today, there are not any generally accepted methods to evaluate the effectiveness of serious games (Roman & Brown, 2008). Moreover, there is no accepted practice for how to use the serious games in training or analysis. A close look at what operators are actually doing indicates that serious games will never replace live training. Rather, they seem best suited as training multipliers. Serious games do not reduce live training; they make it more effective (Roman & Brown, 2008). Serious games seem most effective when used for the development of cognitive skills, such as decision making in a chaotic environment. Users do not learn psychomotor skills as well from serious games. A common problem in serious games is situational awareness. Serious gaming has not been without research; indeed, a growing body of work has shed some light on the topic. The second section of this chapter highlights research that is relevant to this thesis. However, research thus far has only proven that serious games offer potential, but the benefit must be weighed against some important limitations. To explore these ideas more fully, the discussion will turn to the specific platform at the center of this research: *VBS 2*™. Before leaving the more general discussion, a summary is in order.

9. Our Stroll Through History Tells Us Quite a Bit About Serious Games

At this point, listing key points from the preceding wargaming history is helpful:

- Wargames have ties to war that are almost as long as the history of war itself.
- Wargames have never replaced a training area in its entirety; they have supplemented training.
- Serious games have potential to train at the tactical, operational, and strategic level.
- Serious games apply in the cognitive decision-making domain.
- Relative to live training, serious games can be a cheap, readily available form of training any time and any place.

- Serious games appeal to the new warfighter coming from the wired generation.
- Serious games can tie the military to the civilian world and vice versa.

10. *VBS 2™* is the Marine Corps' Bid to Capitalize on the Potential of Serious Games

The Marine Corps has moved forward with an initiative that illustrates the potential of serious games. With the relative success of *Marine Doom*, the Marine Corps sought a commercial gaming product that would enable tactical training across a wide range of warfighting domains. Bohemia Interactive, an Australian company, manufactured *Operation Flashpoint*, a commercial game that could be modified to fit the service's needs. The Marine Corps reviewed the game in depth and issued a statement of work to modify the game into a realistic Marine environment with exclusive rights for future modifications as necessary. *VBS 2*™ resulted from the request. *VBS 2*™ is a first-person shooter game that can be networked to involved many players at once. Using a drag-and-drop menu, game administrators can develop virtually any realistic scenario on the various terrain databases available in the system. Game versatility easily allows players to drive armed trucks through the desert, patrol dismounted in town, work with tanks, artillery, and aircraft in the open field, or interact on a limited basis with civilians and coalition partners. While various games may outperform *VBS 2*™ in different areas, *VBS 2*™ offers the advantages discussed above to individual Marines at their personal computer or battalion laptop.

However well *VBS 2*™ might look on the specification sheet, little has been done to demonstrate or prove that it actually works as a training device. To discuss this issue intelligently, one first must establish what *VBS 2*™ is actually supposed to do. The Marine Corps sought a virtual training platform for individual Marines for all the reasons simulations such as *Full Spectrum Warrior* were developed. Marines were already into gaming from their pre-service years, serious games were cheap, serious games were deployable, serious games were easy to administer. The statement of work for *VBS 2*™ was based on a cognitive task analysis completed in 2004. Program Manager Training Systems (PM TRASYS) contracted with CHI Systems, Inc. and Klein Associates, Inc. to do something best explained by the report's title "Using cognitive task analysis to support cognitive authenticity in training strategies for anti-terrorism force protection tactical decision making" (J. Styer, personal communication, October 27, 2008, and P. Nichols, personal communication, November 12, 2008). *Operation Flashpoint* fulfilled several goals quickly. It was the right size in terms of memory. It provided the right amount of versatility and fidelity. Its flexible and friendly mission editor was deemed critically important. Most importantly, it was close to what the Marine Corps needed, requiring the least amount of modification. As a result, *Operation Flashpoint* was the game of choice, and *VBS 2*™ was born. The only official document linking the game to performance standards was the PM TRASYS cognitive task analysis (D. Mathes, personal communication, October 27, 2008).

The cognitive task analysis did specify performance criteria in measurable Marine Corps terms. At the time, the Marine Corps used a system of "Individual Training Standards" (ITS) that specified required tasks and the precise measurable steps to perform those tasks to standard. The cognitive task analysis listed the ITSs required for the missions they analyzed. The cognitive task analysis focused on the Fleet Anti-terrorism Security Team (FAST) company, an entity representing a relatively narrow, unique skill set. Generalizing this task list to the entire Marine Corps certainly shortchanges the capabilities of *VBS 2*™. The game can do so much more. Thus, identifying what *VBS 2*™ is actually supposed to do is muddy water, and the available documentation simply leaves one making things up based on intuition.

VBS 2™ has experienced some scientific scrutiny, although it has come from outside the United States. In 2002, some Australian computer science researchers at the University of New South Wales began to explore *Operation*

Flashpoint as a tactical training tool. They evaluated users in a series of three exercises in the game. From survey results, they noted such problems as disorientation from the small screen size, lack of simulated fatigue, and unrealistic tactics among computer-generated forces. Players could not practice basic motor skills such as weapons drills. Nevertheless, they showed that the game could be used for tactical training with limitations (Barlow, Morrison, & Easton, 2002). Once the VBS project had matured somewhat, in 2004, the same Australian research team reviewed the game system again. They continued to rate the game as a good tool for section level training, although situation awareness issues still topped the list of limitations. The AAR capability requested by the Marine Corps added significant capability to the game (Morrison & Barlow, 2004). In the same year, one of the researchers worked with a group at the Virtual Environments & Simulation Laboratory (VESL) to study how squad leaders make decisions under the stress of battle. The team successfully demonstrated that serious games can be used for analysis as well as training (Barlow, Luck, Lewis, Ford, & Cox, 2004). The next year, the team highlighted a striking limitation of *VBS 2*™ and serious games in general: that is, players must practice with the game for periods ranging from a few hours, for basic skills, to a week or more for more complex team leading tasks in order to use the game seamlessly as an extension of their warfighting skills (Morrison, Barlow, Bethel, & Clothier, 2005). All of this research supported the murkiness of the situation: serious games have potential as a training tool, analytical asset, and rehearsal mechanism, but these benefits come with notable limitations. Clearly, the research suggested the need for a closer look at tactical performance on the ground after game training.

More recently, the Canadian Combat Training Centre demonstrated some degree of effectiveness for *VBS 2*™. They incorporated the serious game into their Troop Warrant Officer's course, reducing live field training while increasing performance results. Their experimentation resulted in very specific data showing that use of *VBS 2*™ resulted in a more effective blended training program, but the effort was not structured in a way that would show specifically which aspects of the serious game worked and which did not. For one serial of the course, the school used 1 day of *VBS 2*™ training and 5.5 weeks of live training in the field. Noting success from use of the simulation, the school turned 2.5 weeks of the live training into *VBS 2*™ training and noticed a significant improvement in success rate in field exercises. However, because the school was merely getting training done and not running a formal experiment, these results were tainted with confounds, such as changes in instructor cadre (Roman & Brown, 2008).

The background study thus far has demonstrated the potential of serious games, and that *VBS 2*™ is well designed to realize that potential. While *VBS 2*™ has been examined in the scientific and academic arenas, however, nothing but anecdotal evidence exists to demonstrate its effectiveness. Intuition and research thus far indicate that *VBS 2*™ has much to offer the individual Marine. Clearly, a glimpse into this effectiveness, or lack thereof, is warranted. The next section examines how this might be accomplished.

C. TRAINING TRANSFER

Training transfer is the idea that training produces results in the form of trainee performance improvement as intended. It seems simple enough, on the surface, to test: just get two groups of people, train one group the old-fashioned way and the other group using the method under investigation, and compare the results. Intuition dictates a few complexities, such as the need for measurable results and the standardization of peripheral factors so that the effects of the new training method can be isolated. However, training transfer studies are not necessarily as straightforward as they may seem, and an examination of past studies and related research sheds some light on the difficulties.

Several combinations of words exist in conjunction with the word “transfer” that revolve around a similar group of concepts. For the purposes of this thesis, it is worth taking a closer look at two of these word groupings. Transfer of training, which is assumed to be the same as training transfer, is defined as "the extent of retention and application of knowledge, skills, and attitudes from the training environment to the workplace environment" (Bossard, Kermarrec, Buche, & Tisseau, 2008). Transfer of learning is a slightly different concept that applies to the educational arena. If transfer of learning is accomplished, a student can generalize something learned in the classroom to broader application areas, so that the individual uses knowledge gained from the learning process to solve problems that have not been presented before. As a rule of thumb, transfer of training generally applies to work and transfer of learning applies to education (Bossard et al., 2008). Both concepts share the idea that knowledge and skills can be applied in a practical, measurable environment.

In virtual environments, a concept appears throughout relevant literature that differentiates between transfer related directly to the training context and transfer generalized beyond the context. Vertical transfer refers to the ability of the learner to recognize elements of the training context and apply what he or she has learned to problems of increasing complexity. Horizontal transfer, on the other hand, describes the learner's application of knowledge and skills gained through the training to general problems that extend beyond the immediate context of what was taught. Other terms, such as "near" and "far" or "general" and "specific" have slightly different meanings but hinge on the same idea. Whatever the terminology, it is important to keep in mind that transfer of largely procedural knowledge in a set list of clearly defined steps is much different than transfer of generalized situational knowledge applied in varying circumstances. Moreover, context is considered critical; some argue that context is so important that straying from the original context eliminates the possibility of transfer (Bossard et al., 2008).

1. The Trainee Matters

People learn in different ways, and these differences affect the level of transfer. Cognitive ability affects the amount of transfer, with one study concluding that this factor accounts for as much as 16% of the variance in training effectiveness. Self-efficacy has its own effect; if an individual does not feel competent to perform a task, the training transfer will quite likely suffer. Motivation can affect transfer in a couple of ways. An individual may or may not be motivated to train, influencing the effectiveness of the effort. An individual may not be motivated to use the skills in the real world, an issue called motivation to transfer. Personality traits can affect transfer; among those studied with transfer impact are anxiety, openness to experience, extroversion, and conscientiousness. Training transfer tends to be maximized when the individual perceives that the knowledge and skills being trained will improve a relevant aspect of his or her work performance. Training transfers better with increases in the trainee's job involvement. Training transfer also depends on the degree to which the individual identifies with his job and considers improvements in performance important to his self worth. Science has not yet shown the perfect profile of the individual who will easily transfer training or the individual who will struggle with it, but the science is clear that transfer will differ from person to person. Some key characteristics, such as cognitive ability, pretraining motivation, negative affectivity, and perceived utility, may help identify those individuals who will struggle in a training transfer endeavor. More importantly, one may be able to take actions in the training phase to minimize the effects of some of these characteristics, such as negative affectivity or perceived utility (Burke & Hutchins, 2007).

This thesis does not seek to expound in depth on the various schools of thought in learning psychology, but it is helpful to quickly highlight the three most common theories: behavioral learning, cognitive learning, and constructive learning. Psychologists adhering to the behavioral approach contend that the human mind is a sort of black box, where inputs can be studied and outputs can be studied, but the mental processes in the middle are ignored. Key side notes from this school of thought are the idea that the learner adapts to the environment and the concept of learning as a largely passive process.

Proponents of cognitive learning, on the other hand, focus on the black box itself, attempting to model what goes on inside the learner's brain. In cognitive learning, the individual conceptually has a knowledge base and uses processes and symbols to map what is taught into the base. Thus, study of this approach seeks to identify and describe those processes and symbols. Both behavioral and cognitive learning approaches view the learning process as one in which the knowledge presented is set and absolute, like a traditional classroom lecture environment. Psychologists adhering to the constructivist school of thought challenge this idea, contending that each learner reconstructs the facts presented in his or her own way to build the internal knowledge base. Like the cognitive approach, knowledge is viewed as a combination of symbols and processes to access a knowledge base in the head, but the constructivist approach holds that each individual has his or her own world perspective based on individual experience (Bossard et al., 2008).

Military training often reflects a behavioral approach out of necessity. Training typically occurs en masse, and proficiency is achieved through repetition, discipline, and remediation. The situation changes when training orients on decision making. In a platoon training event, a junior Marine may experience a primarily behavioral training regimen while the platoon commander experiences a more cognitive or constructivist approach. As pointed out in the training transfer introductory section, transfer itself may be contextually specific or more generalized. These taxonomies become important to the discussion of unit level training. In the team environment, some individuals may be learning very lock-step, procedural tasks while others may be learning very abstract, generalized decision-making schemes that will most likely be applied in new and unique situations. When the overall transfer of group training is under the microscope, one must bear in mind the different training models in place at the individual level.

When technology is used for training, the trainee's attitude toward that technology can influence the training experience. A U.S. Army project explored this idea. A first-year class of cadets at the U.S. Military Academy trained with America's Army, a game discussed in the first section of this chapter. The research team sought to determine whether gaming experience and computer self-efficacy affected four learner outcomes of interest: training motivation, training satisfaction, ease in using the game interface, and perceived team cohesion. Not only did the research team find that these two factors affected learner outcomes, but they found that the type of experience mattered as well. For example, gamers who used products similar to America's Army had higher training motivation, training satisfaction, ease in using the interface, and perceived team cohesion than gamers who played much different games (Orvis, Orvis, Belanich, & Mullin, 2005). As pointed out above, a trainee's learning style matters, but a trainee's experience with computer technology in general, and experience with technology similar to that used for training, makes a difference as well.

2. The Way Training Is Done Matters

The design and delivery of the training intervention can affect transfer. Before the training is planned, a needs analysis can determine whether it is needed. If the training is not necessary, training transfer results will obviously suffer accordingly. During the training intervention, establishment of learning goals and objectives positively impacts training transfer; that is, people learn better if they know what is expected of them in the course of the training. Content relevance is also important; trainees must see a relationship between training content and work tasks.

The way the material is taught influences training transfer. Practice and feedback provide the opportunity for trainees to reinforce what has been presented, enhancing transfer in the long run. Overlearning, the practice of having individuals continue practicing even after they have correctly demonstrated the skill, can improve transfer of training by making responses automatic. Trainees can experience cognitive overload, in which they are presented more than they can learn at one time. Strategies that minimize information not necessary for learning, while maximizing the information that directly contributes to learning, improve training transfer. Active learning quite likely affects transfer more positively than lecture, although the literature is inconclusive on this point. Error-based examples help trainees learn a skill by showing aspects of the task that can go wrong, and such strategies have been found to increase training transfer (Bossard et al., 2008).

A common workplace phenomenon is the individual returning from a training workshop with the newest way of doing something. Quite likely, that individual returns to a skeptical crowd, unwilling to bother with changes to the status quo. In the end, the individual's training might end up useless. The individual may have learned the knowledge and skills perfectly. He or she may have been able to apply them any time and any place. The individual may have returned with a burning enthusiasm to apply the knowledge and skills immediately. Nevertheless, all of this failed in the face of resistance back in the office.

The organization itself is critical to training transfer. For example, training transfer improves if the trainee perceives a direct link between the training and the supervisor's strategic goals. The propensity for the organizational atmosphere to contribute to training transfer is described by the term "transfer climate." A positive transfer climate encourages use of the newly trained skills and incentivizes their correct application. Supervisory support impacts training transfer. The support of peers is even more important than the support of supervisors. If a skill and applied training technique gain acceptance at the water cooler, transfer improves. The organization also contributes to positive training transfer by affording the opportunity to perform the newly acquired skills. The organization's methods and pressure to hold individuals accountable to what they have learned seems to affect training transfer as well, although the available research fails to describe this link in detail (Bossard et al., 2008).

3. Numbers Matter

The practical matter of assessing training transfer is based on quantifying results of some job or skill performance. Ultimately, performance must be translated into a number or combination of numbers that can be statistically compared and analyzed. Performance measurement is a science all of its own, and the problems are exacerbated when reviewing performance of teams instead of performance of individuals. Jack Zigon presides over a consultant firm specializing in team performance measurement systems. He highlighted three reasons team performance measurement is difficult:

- It is not always obvious what results should be measured.
- Even if you know what to measure, it is often not clear how the measurement should be done.
- Teams are made up of individuals, thus measurement must be done at both the team and individual levels.

Zigon's work oriented on the corporate world, but he offered some advice that is useful for any performance measurement. First, he recommended focusing on results, because data related to the activity that produced the results can be misleading or uninformative. Second, he discussed the creation of measures for each accomplishment, noting that measures cannot always be numerical. He categorized measures into numeric measures that use quantification of some concrete aspect of the accomplishment and descriptive measures that use words for evaluation. Third, he recommended developing a system of performance standards. These standards use the measures from the second step to determine how a team performs against a set goal. Finally, Zigon suggested the implementation of a feedback system. The feedback system provides the individual, the team, and the organization an assessment of the performance (Zigon, 1998).

The project that is the subject of this thesis seeks to capitalize on years of Marine Corps experience in team performance evaluation to prevent a reinvention of the wheel. The Marine Corps Mission Performance Standards

(MPSs) list all of the skills Marines in a particular job specialty should perform to be proficient within that specialty at each rank of service. Marine Corps Order (MCO) P3500.72A, dated 18 April 2005, outlines the training and readiness program that incorporates these MPSs into a training regimen for ground forces. In the publication's introduction to Marine Corps training philosophy, MCO P3500.72A explains in very direct terms how the service views training and training evaluation: "Training Marines to perform as a team in combat lies at the heart of the Training and Readiness (T&R) Program. Unit readiness and individual readiness are directly related." The publication then specifies the tenets on which the T&R concept is built:

- Focus on expected combat missions
- Building block approach to training
- Focus on Individual Core Skills and Unit Core Capabilities
- Organization of tasks into executable events
- Sustainment of training

MCO P3500.72A addresses core skills, which apply to the individual, and core capabilities, which apply to the section or unit. An individual must be able to perform core skills to be qualified for his or her job specialty. A section or unit must be able to perform core capabilities in order to meet performance expectations in contingency operations or combat. Closely related to these concepts are Mission Essential Tasks (METs) which are those tasks that form "the very essence of the community's existence." Skills that are "environment, mission, rank, or billet specific" are core plus skills, and advanced functions that are "environment, mission, or theater specific" are core plus capabilities. In order to understand the organization of the MPSs, one must keep in mind the building block approach used by the training and readiness program. The program organizes the standards as executable events that units can arrange into appropriate field exercises and training programs. Some standards serve as prerequisites for others, and units can use chaining to give sustainment credit for simpler tasks that support more advanced events. In this way, the training and readiness program serves as the basis for school syllabuses as well as peacetime training in operational units. The same program that defines requirements for entry-level job specialty training also specifies how individuals in that job specialty will train throughout their careers and how their units will train as well.

The training and readiness program evaluates training in two ways. Proficiency measures performance of a certain skill or set of skills against a set standard. Currency evaluates the standard against a sustainment interval for the particular event. Thus, training may be necessary because an individual or unit cannot perform a skill well enough, or because too much time has elapsed since the skill was last performed.

The administration of the training and readiness program supports organizing and analyzing training events. Each MPS is coded with a series of three four-character codes. The first four-character grouping indicates the job specialty, the second four-character grouping indicates the functional area or duty area, and the third four-character grouping indicates the level and sequence. The program ultimately seeks to measure a unit's preparation for each of its METs. The Combat Readiness Percentage (CRP) quantifies this preparation. Specific events that support a MET for CRP calculation are called evaluation coded events or E-coded events. Thus, E-coded events are those that contribute to an overall grade or numerical evaluation.

Each MPS has a title and a description that explains the purpose, objectives, goals, and requirements of the event. The event's condition lists the items, such as equipment, manuals, tools, and aids, that must be provided as well as any specific conditions under which the event must be performed. The event's standard explains the minimum acceptable level of performance of the event and how the level of performance will be judged. Each event has a list of performance steps that guide an evaluator to ensure all components of the MPS have been satisfied. An event may have a list of prerequisites or chained events. Finally, each event has a list of references and support requirements. For each task supporting a unit's mission, the training and readiness system specifies what the task is, how to do it, how to measure it, and how to support it.

Navy and Marine Corps Publication (NAVMC) 3500.87 is the Marine Corps' infantry training and readiness manual. With more than 600 pages of documentation, the publication explicitly states how the Marine Corps infantry should train, from the individual riflemen through the large battalion and regimental staffs. NAVMC 3500.87 meticulously follows the guidelines of the training and readiness program, providing a highly detailed and organized method of delineating what tasks must be accomplished for any given mission, how they will be accomplished, and how they can be graded.

4. Determining What Matters

Lisa Burke and Holly Hutchins (2007) collaborated on an integrative literature review of training transfer. In summarizing available research, they recommended that training transfer be assessed as "a multidimensional phenomenon with multilevel influences." This concept is probably the most critical idea related to training transfer. Transfer is not a black and white switch that either happens or fails to occur. Rather, the individual trainee, the training plan, and the training environment all have many variables working together to influence the degree of transfer. Understanding these potential variables allows one to try to minimize their impact but, in the end, many factors can affect the final transfer of training.

Applicable literature recognizes this multi-factored aspect of training transfer. One model proposed to deal with the issue is the generalized Learning Transfer System Inventory. LTSI attempted to design a scaling system for measuring transfer based on various factors. The generalized study included sixteen factors analyzed via questionnaire. While LTSI took individual level training transfer a step too far for this thesis, an overview of the sixteen factors is useful. Some of the factors focused on the individual, such as learner readiness, motivation to transfer, positive and negative personal outcomes, and personal capacity for transfer. Other factors focused on the environment or climate such as peer support, supervisor support, supervisor sanctions, performance coaching, and opportunity to use. Several factors related to the way the individual perceives the training affecting him or her, such as perceived content validity, performance expectations, performance outcomes expectations, and performance self-efficacy. Finally, the transfer design itself affects transfer. When researchers study training transfer, reporting information about the circumstances of the training experiment using these factors can help standardize studies in the aggregate. More practically, though, the LTSI model itself can help the training organization as an indicator of transfer inhibitors so that they can be minimized. For the purposes of a training transfer study like the one proposed in this thesis, LTSI provided a sort of guideline for factors that need to be controlled throughout the study in order to isolate the effects of the training mechanism itself (Holton, Bates, & Ruona, 2000).

In summary, training transfer depends on many factors, and any attempt to measure transfer must take this into account. A list of pertinent notes from this study follows:

- Trainees learn differently.
- Transfer improves if the trainees know what they are doing and why.
- The training climate can positively or negatively impact training.

While the Marine Corps has a ready-made system of evaluating training, these factors proved important throughout the course of the project.

5. A Tribute to Those Who Have Gone Before

Simulator use without robust training transfer research is prevalent across a wide variety of training domains, including medical procedures training, nuclear power plant operation, commercial aviation, and the NASA space program. The bottom line is that training transfer research is hard. Human performance is difficult to measure, and the difficulties expand when the exercise involves teams. Additionally, training is quite likely not the sole contributor to subsequent proficiency. A proper evaluation must isolate training from other factors such as environment, leadership, and equipment (Thurman & Dunlap, 1999). Nevertheless, some research projects have evaluated the training transfer of personal computer-based training. While the following list does not strive to be comprehensive, it demonstrates some of the efforts that have been made and the successes and challenges encountered along the way.

A research project at the Israeli Air Force flight school used a personal computer-based game called *Space Fortress II* to help train cadet pilots. Two groups of cadets received ten hours of simulation-based training while a control group received traditional training. The effects of the training were evaluated in a series of eight flights that were part of the training program. Flight instructors graded the cadets' performance on several criteria with numerical markings and then gave the students an overall score. Comparison of the results indicated that both simulation groups performed better in the live flight exercises than the control group. One of the simulation groups trained using single task games. These part-task trainees trained with one part-task game at a time with feedback on each game. Afterward, the trainees played the whole game. The other group trained with the whole game only, receiving feedback at the end. The researchers found that the trainees who had used the part-task games outperformed the cadets who trained with the full game (Gopher, Weil, & Bareket, 1994). This study shows how a personal computer-based game can result in enhanced performance in the real world.

In 1998, a British study explored the use of Microsoft Flight Simulator to train pilots. This study featured two simulation groups: one group completed the simulation using controls similar to those in an airplane, while the other group used keyboard and mouse controls. A control group trained using traditional means. Students then flew real-world flights after the training, and flight instructors rated designated skills on five-point scales. The study determined that both simulation-trained groups performed better than the control group.

Also, the group trained in the simulation with controls that were similar to those in an airplane performed better than those who used the keyboard and mouse interface. The researchers concluded that a low-resolution trainer such as a personal computer-based game could effectively contribute to training in the early stages of a pilot's career. The authors were careful to point out that their results did not suggest that personal computer-based simulations aided in psychomotor skill acquisition. Also, the study was limited to a relatively simple flight task of flying a square where subtasks included flying straight and level and entering and exiting turns. The study could not generalize its findings to more complex tasks like taking off and landing (Dennis & Harris, 1998). However, this study shows another definitive instance of personal computer-based training enhancing real-world performance.

A 2007 study at Bristow Academy, with a commercial personal computer-based game called *X-Plane*, sought to determine whether personal computer-based gaming technology could be used for helicopter training. The experiment involved three groups, differing by interface: those in a mock cabin with motion feedback, those in a mock cabin without motion feedback, and those using a desktop interface. The researchers measured training transfer by determining whether each group showed improvement in the simulator. Analysis of experiment results yielded conclusions that both cabin arrangements provided training transfer while desktop configurations resulted in no significant transfer. Also, experiment results indicated that motion did not significantly contribute to training transfer, although feedback questionnaires from participants indicated a strong desire for motion feedback. A deeper look at the difference between cabin and desktop interfaces suggested that the real contributor may have been visual feedback, because the cabin screens were larger than desktop monitors. Interestingly, the school that served as the test site opted for a full mission simulator instead of the game approach used in this research, despite the experiment's indications that training effectiveness could be gleaned from this "serious game." However, this study was somewhat limited in scope. In this study, only the simulator performance provided evidence of training effectiveness; there was no attempt to see whether performance in the actual aircraft improved (Proctor, Bauer, & Lucario, 2007).

Other training transfer experiments explored the use of personal computer-based training outside the aviation training community. In 2005, two Naval Postgraduate School students built a first-person shooter simulation to train for artillery forward observer procedures. Forward Observer Personal Computer Simulation (FOPCSIM) allowed a single user to learn basic call for fire procedures and practice them in a realistic virtual environment. The project then took the simulation to the Marine Corps basic officer training course where call for fire is one of the fundamental skills taught. They used FOPCSIM to train one group of Lieutenants, and the other Lieutenants were trained with the old theater simulation called Training Set, Fire Observation (TSFO) where call for fire results were projected in a slide show. The research used the basic school written exam as a metric for determining proficiency. The researchers determined that the personal computer-based game performed as well or better than the TSFO. Most notably, FOPCSIM was much more efficient; since trainees were automatically scored, they could perform as many missions as their pace would allow, instead of proceeding at the pace of instructor observation in TSFO. However, the research project was unable to test the effects of the training in live fire (McDonough & Strom, 2005).

The training transfer examples cited so far focus on procedural trainers for individual tasks. This thesis seeks to explore the domain of small unit tactical operations, and some research has investigated the effectiveness of personal computer games in this area. In 2005, a separate Naval Postgraduate School project sought to determine whether commercial off-the-shelf (COTS) gaming technology could improve training. U.S. Army Majors J. Nolan and J. Jones used *Delta Force: Black Hawk Down-Team Sabre*™ as a small unit tactics training platform at the Infantry Officer Basic Course in Fort Benning, GA. The two researchers compared survey data from a control group who did not use simulation and a test group who used the COTS game. They found only limited statistical differences in the soldiers' confidence across a 50-question survey. Primarily, the surveys indicated that the simulation training did not hinder performance in any way, but it provided virtually no evidence that the simulation improved performance. The researchers described the most interesting data as group interview results where the officer controlling the exercise noticed improvements in movement in tactical formations as well as better use of binoculars in security tasks. Nolan and Jones's study demonstrated that serious games could be used for training, showed no evidence that the training technique was better than traditional means (Nolan & Jones, 2005).

Starting in 2000, the Office of Naval Research sponsored a large research project called VIRtual Technologies and Environments (VIRTE). This program studied the use of simulation and virtual environments in many different ways to support the emerging over-the-horizon amphibious triad of the new landing craft, amphibious personnel carrier, and tilt-rotor aircraft. The project emphasized training transfer as the ultimate objective from the very beginning (Muller, Cohn, & Nicholson, 2003). Part of the project involved the development and evaluation of a personal computer-based game called *Combined Arms Network* (CAN) to train Fire Support Teams (FiSTs). The resulting transfer study was one of the most comprehensive personal computer-based game transfer studies ever done. Experiments were conducted with all facets of the Marine Corps, including active and reserve units, operational units and schoolhouses, basic training and advanced training, and ground and amphibious operations. The research project involved the administration of surveys and, when possible, the evaluation of live exercises after training. In general, the research showed evidence for training transfer in all groups through increased efficacy ratings on the surveys. This project was unique because its breadth exposed the individual appeal of a given training tool. That is, efficacy increased, but it increased for different reasons for each group studied (Becker et al., 2009). While this study was an overall training transfer success, it points to the dangers of over-generalizing results.

Another recent transfer study endeavored to show the effectiveness of serious games for unit training. A 2007 study used a personal computer-based game called *Close Combat: First to Fight* to train urban combat operations. In this experiment, a sixteen-Marine simulation group used the game for training while another sixteen-Marine group used traditional training methods. Performance was evaluated in a live fire shoot house, where the Marines conducted a standardized Close Quarters Battle (CQB) exercise in four-man teams. Also, Marines completed a survey in which they rated the usefulness of the simulation training for a list of tasks that were trained in the exercise. Statistical analysis showed no difference in performance in the live exercise as assessed by the objective grading of the CQB. However, the survey results indicated that Marines felt the simulation training increased their proficiency in the tactical skills that were trained (Proctor & Woodman, 2007).

6. The Road Ahead

After looking at these training transfer studies as a group, one can note some important trends:

- Research has shown most success in the training transfer arena when focused on individual, procedural tasks.
- Three measures of effectiveness are commonly used: surveys to gain insight into participants' self-assessed proficiency, knowledge tests to determine participants' academic understanding of the skills; and instructor- or Subject Matter Expert-rated evaluation in the real world.
- Of the three measures of effectiveness listed above, the subjective self-assessed proficiency is most likely to show results, particularly for collective, cognitive tasks like a small unit tactical exercise.
- Personal computer-based game effectiveness is more apparent when the research project involves novices.
- Personal computer-based games can produce enhanced performance in the real world, but research has not yet established a pattern or formula for when they are effective and when they are not.

Training transfer in other simulation domains has drawn attention because of its difficulty, so researchers have studied groups of transfer projects to determine Best Practices and pitfalls. Boldovici (1987) compiled one of the earliest examinations of modern simulation transfer studies. He listed the following pitfalls:

- Small numbers of soldiers or crews are used in the comparison;
- Subjects in the compared groups are not matched or randomly assigned;
- Groups are treated differently in respects other than those under investigation;
- Weapon system error masks training effects;
- Amount of practice is insufficient to affect proficiency;
- Ceiling or floor effects mask differences between groups;
- Measurement of Task B performance is unreliable;
- Inappropriate analyses are used to estimate transfer (Boldovici, 1987).

A component of learning theory that is particularly pertinent to the use of personal computer-based games for training is experiential learning. According to this theory, people learn from the experience of the task. Recent research in this topic describes experiential learning as a cycle of experiencing the environment, observing behavior and reflecting on the experience, generalizing based on the reflection, and modifying concepts based on new experiences. The researchers propose an idea that is interesting to military trainers: trainers can tailor the environment so that learners incur certain experiences according to a structured plan than can flex to the needs of the trainee. In order to accomplish such a plan, the learning events must:

- Engage the learner mentally.
- Emulate real-world requirements. Real-world refers to the physical environment and the cognitive tasks.
- Allow the learner to experience effects of decisions.

- Require learner to reflect on outcomes of their actions. Build on established military practices of debriefs, lessons learned, and after action reports.
- Revisit experiences increasing complexity of experiences to expand learners' knowledge and skills by increasing number of events, pacing and emotional intensity (Menaker, Coleman, Collins, & Murawski, 2006).

Personal computer-based learning is a tool for experiential learning, and the list above provides a formula for what the serious game and the trainer must accomplish together in order for the trainee to learn. While this formula does not guarantee training transfer by any means, it provides guidance on how to structure the training event to create the best environment for training transfer to take place.

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III. PREPARATORY EXPERIMENTS

A. INTERFACE FAMILIARIZATION PILOT STUDY

1. Introduction

Serious games face a potential drawback because of their interfaces. Game manufacturers expend much effort producing the most intuitive, efficient, and user-friendly interface for their software but, for any game, users must learn the interface. Military personnel training with a serious game must be able to move, shoot, and communicate as they would in live training. The game interface must serve as an extension of the servicemember's warfighting skills. Interface training clouds the potential gain of serious game training because of the extra time required. If the individual did not have to learn the game, he or she could do something more productive. The military does not need gamers for gaming's sake; gaming only serves as a means to an end. With this in mind, military serious game endeavors should strive to minimize time lost to learning the interface.

This section summarizes a pilot study conducted as part of a project to examine the training effectiveness of Bohemia Interactive's *Virtual Battlespace 2*™ (*VBS 2*™) to train small unit tactics in a personal computer-based environment. In order for the simulation to be useful, Marines must use the interface to proficiently drive vehicles, shoot weapons, and maneuver their bodies as they would in the real world. We sought to provide the minimal computer interface skills to enable Marines to operate in a small unit mounted or dismounted environment. We developed an interface training program to prepare Marines as quickly as possible so that they could devote most of their simulation time to tactics training.

The military seeks serious games to support training for a variety of reasons including their deployability, relatively low cost, and flexible training environments. Additionally, the military wants to keep in touch with the wired generation, the youth who have experienced a childhood full of MP3 players, compact discs, computers, cell phones, and XBoxes. In 2008, a market research firm called the NPD Group reported that 72% of the U.S. population played video games in 2007 (Antonucci, 2008). Later in the year, the Pew Internet & American Life Project found that 97% of 12- to 17-year-old respondents played video games, they played them often, and they played a wide variety of games (Irvine, 2008). However, the military cannot count on gaming skills in all of its personnel. Roger Smith serves as the Chief Technology Officer for the U.S. Army Program Executive Office for Simulation, Training, and Instrumentation (PEO-STRI), so, in looser language, he is the Army's official shopper for serious games. In August 2008, Smith responded to an interview question about modern soldiers' familiarity with computer games:

> Our research and hands-on experience shows that about 50% of young enlisted soldiers call themselves "gamers" or are familiar with the mechanics of game play. At the officer level it is around 33%. We have learned that we cannot assume that all soldiers have this familiarity. (Atkinson-Bonasio, 2008)

A U.S. Army research effort to determine the influence of gaming experience on trainee satisfaction with serious games showed similar results. A survey of the first year class at the U.S. Military Academy revealed that 17% of the cadets had no gaming experience and 44% had limited gaming experience. The researchers concluded that an orientation with relevant games would likely enhance the training experience (Orvis et al., 2005). While the wired generation may know cell phones and iPods, they do not necessarily know how to use the games that support military training. Moreover, military training cannot leave the 50%, 28%, 3%, or any other percentage of non-gamers behind. To use serious games for tactical training, all servicemembers must play. The experience of the wired generation helps, but the military simulation professional must craft exercises with the novice user in mind.

VBS 2™ has enjoyed some scientific scrutiny, and this prior research has shed some light on the time required to use the simulation as an extension of one's warfighting skills. In 2004, an Aussie research team conducted a weeklong trial to determine the potential utility of *VBS 2*™'s predecessor VBS 1. The trials involved a group of participants with varying degrees of computer and gaming experience with roughly half the people having no gaming experience. The study determined that nearly 80% of new users can attain individual skill proficiency within a couple hours. For higher-level cognitive skills such as situational awareness and team leadership, people need up to two days to become proficient in the game play (Morrison et al., 2005). The author's personal experience with the simulation at the I Marine Expeditionary Force (MEF) Simulation Center in Camp Pendleton suggested one could reduce this timeline. There, Marines started training with only a 30-minute brief, and a telephone call confirmed that the I MEF Simulation Center currently uses this practice (D. Gerdes, personal communication, January 14, 2009). The I MEF Simulation Center uses a locally crafted slide presentation to brief Marines for about 15 minutes. They provide about 15 minutes of free practice time and supply users with a single page "cheat sheet" of interface commands. However, the I MEF Simulation Center has many Marines trained to help simulation users during the conduct of the exercise. This pilot study sought to capitalize on this model and develop an interface training program to prepare *VBS 2*™ users within the 30-minute goal.

As a pilot study supporting a larger project, this project served two main purposes. First, as the background literature indicates, progress in future *VBS 2*™ projects requires knowledge of how to handle the interface. One cannot determine how well *VBS 2*™ contributed to some aspect of training if a user's confusion with the interface muddies the waters. Thus, this project started with a guess of an appropriate technique for accomplishing interface training and sought to determine whether the technique was adequate.

Second, for planned future projects, groups and teams will use *VBS 2*™ as a common environment to interact toward some unit goal. A lone researcher in a laboratory can troubleshoot only a limited number of issues in support of such a project. Common sense dictates that many unpredicted problems and quirks will arise from group use that the lone laboratory developer can never find by himself. In this regard, this pilot study served as the first effort in the larger project of having multiple people work together in a common environment.

This pilot study shed light on the answers to two questions:

- Will the 30-minute presentation and practical application technique of interface training suffice to enable users to practice small unit tactical skills in *VBS 2*™?
- What unanticipated problems will arise when a group operates in a common *VBS 2*™ environment?

The pilot study supports a larger project to use *VBS 2*™ to train Marines in small unit convoy tactics. That project involves Marines patrolling a designated course in six to eight vehicles armed with heavy weapons. The course trains the following skills: react to an unexploded improvised explosive device (IED), react to an IED detonation, take immediate action against a blocked ambush during a convoy, take immediate action against an unblocked ambush during a convoy, evacuate a damaged vehicle, and evacuate a casualty. From these skills, we derived a list of *VBS 2*™ interface skills a user must know to use the simulation for the convoy training. These interface skills include: individual body movements, manipulation of personal gear, use of personal weapons, vehicle interaction and operation, use of vehicle weapons, manipulating a casualty, towing a vehicle, disarming an IED, and recognition of friendly, civilian, and enemy avatars. The pilot study endeavored to train these interface skills.

To answer the first question listed above, we developed a criterion for success. We based success on the level of comfort users felt in performing each of the tactical skills listed above. We determined this comfort level through Likert scaled responses to each of the skills. We viewed success as a mid-level comfort rating for all skills.

2. Method

a. Participants

Twelve Naval Postgraduate School Modeling, Virtual Environment, and Simulation (MOVES) graduate students, ranging in age from 27 to 41 years, participated in the pilot study. All participants volunteered as part of a seminar course on current simulation technology. All the participants were male military officers with service times ranging from 4 to 24 years. Four foreign officers participated, and U.S. officers represented all four of the armed services.

b. Apparatus

The project used twelve Dell Precision M6300 laptops from a suite of the Marine Corps Deployable Virtual Training Environment (DVTE) package. Peripheral equipment, including mice, cables, and switches, came from the standard DVTE package. For the familiarization training and evaluation, we networked the computers in pairs with four computers per switch. As shown in Figure 2, paired users faced each other at a classroom table so that they could not see each other's screens. For the follow-up evaluation, all twelve computers were networked together in the same environment using two switches with six computers per switch. Participants operated as individuals in the follow-up evaluation.

Figure 2. Classroom setup for 12 participants

c. *Procedure*

This project used the I MEF Simulation Center's training model of a slide presentation with practice time. The project also provided a single page cheat sheet of interface commands, included in Appendix E. The project modified the interface training by having the trainees follow along in the simulation on their own DVTE computers during the slide presentation. The I MEF Simulation Center cannot use this method because of the physical layout of the facility, but we assumed that the hands-on application would enhance the interface training. With this construct in mind, the project developed a familiarization scenario to guide novice users through the basic individual, weapon, and vehicle skills necessary to use *VBS 2*™.

To support the development of this scenario, the project started by identifying the specific interface skills needed for future tactical training. The pilot study supports a larger project oriented on tactical convoy training. The Marine Corps convoy training supports well-documented service training objectives, and analysis of these training objectives clarified the interface skills needed for the pilot study. An individual must be able to maneuver his body dismounted, including walking, running, and getting into and out of the prone position. He must be able to use personal gear available in the simulation, including compass, binoculars, global positioning system (GPS), watch, and night vision goggles (NVGs). The user must be able to use personal weapons, including rifle and grenade, to accurately engage targets. Other individual skills include recognition of civilians and enemy combatants, recognition of improvised explosive devices (IEDs), and casualty evacuation. In convoy operations, Marines must be able to operate vehicles and vehicle weapons proficiently. Specialized vehicle operations necessary for the convoy operation include towing a damaged vehicle.

Typically, Marines will operate in a convoy scenario in teams of three: a vehicle commander riding in the passenger seat, a driver, and a gunner for the vehicle's weapon system. The vehicle commander does not have to learn any specific vehicle interface skills like the driver or gunner, but he must be familiar with both. For this reason, the interface training was developed for teams of two, specialized for the driver and the gunner. Vehicle commanders could be trained using either station.

The interface training scenario involved two parts: individual training and vehicle training. For the individual training, two Marines operated in the same environment that included a single personal weapons range. Users started in two separate lanes that mirrored each other with the range in the middle. Each user started play in front of his own vehicle. At this position, the user could learn individual movements. Both users moved to firing points on the personal weapons range and practiced M16A4 rifle and grenade target engagement. Also, users practiced using their personal gear. After completing these exercises, users returned to their individual vehicles to start the vehicle training.

Users started the vehicle training by driving high mobility multi-purpose wheeled vehicles (HMMWVs) along a designated course to a vehicle weapons range. There, they used the vehicle's 0.50 caliber machine gun to practice engaging vehicle targets. After practicing with the vehicle's weapon system, the users followed a designated course to a middle Eastern-style house where they could get out of the vehicle and examine each other, three civilians, and two enemy insurgents. Each user shot an insurgent and practiced putting the body in a vehicle. Users also viewed an IED and practiced disarming it. After personnel and IED recognition, the users got in a 7-ton truck, the medium tactical vehicle replacement (MTVR), and followed a designated course to a damaged Landrover. There, they practiced towing the vehicle. After completion of the vehicle towing, the users had five to ten minutes of free practice time. The entire familiarization course, shown in Figure 3, occupied a 3 by 4 kilometer area of the Cleghorn region of the Twentynine Palms terrain database available in *VBS 2*™.

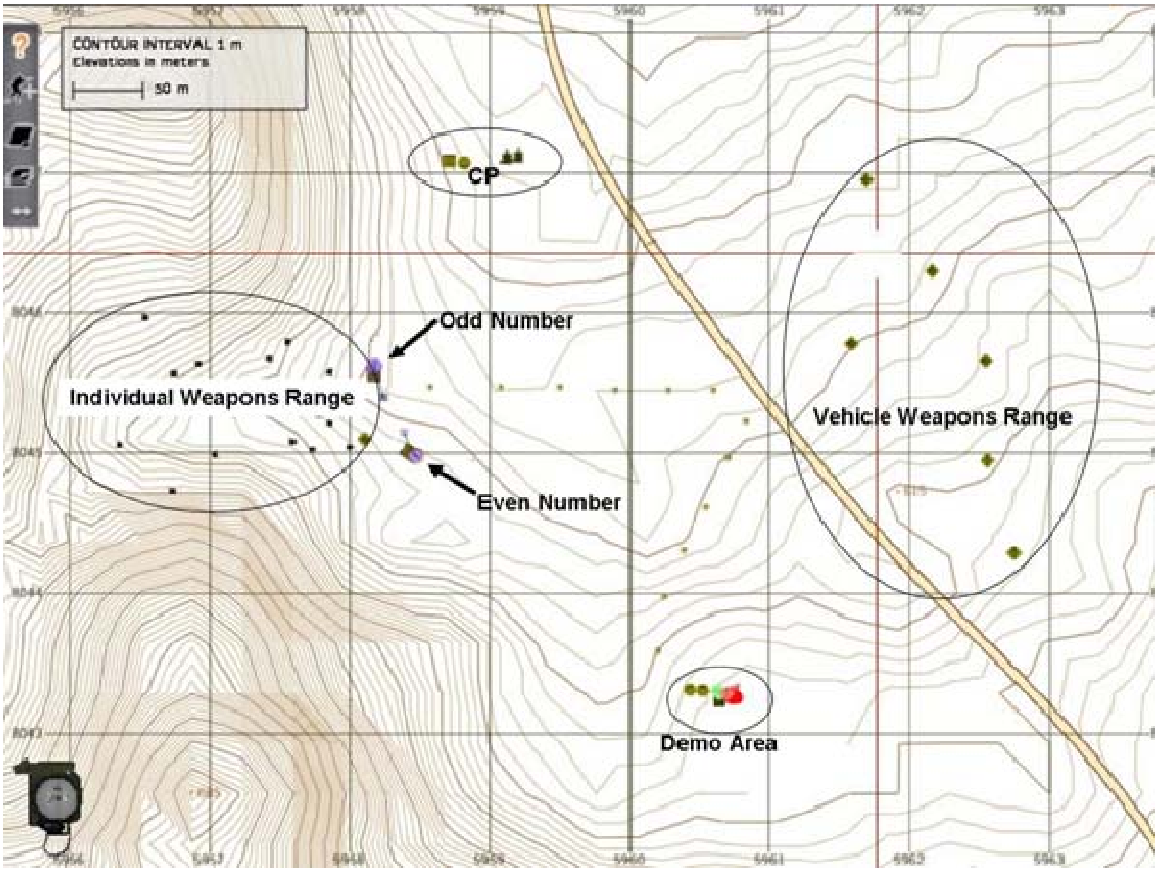

Figure 3. Familiarization training area

We designed an evaluation course in the familiarization scenario to determine the interface skill level achieved by the users (Figure 4). Users started in a fresh MTVR at a known command post location and used signs to follow a route on a mission to tow a damaged HMMWV. Along the route, they encountered four stations briefed immediately prior to the exercise. Station 1 included three enemy trucks, Station 2 included a four-man enemy fire team, Station 3 included a compound with two enemy combatants inside and a well-marked IED outside, and Station 4 included another four-man enemy fire team. A properly executed exercise would result in the three trucks destroyed, all ten personnel targets killed, one of the enemy from the compound loaded into the truck, the IED disarmed, and the damaged HMMWV in tow with the MTVR on the nearest road ready to return. All users had the following resources: a map of the area, a diagram of the familiarization training area, and a cheat sheet of interface commands.

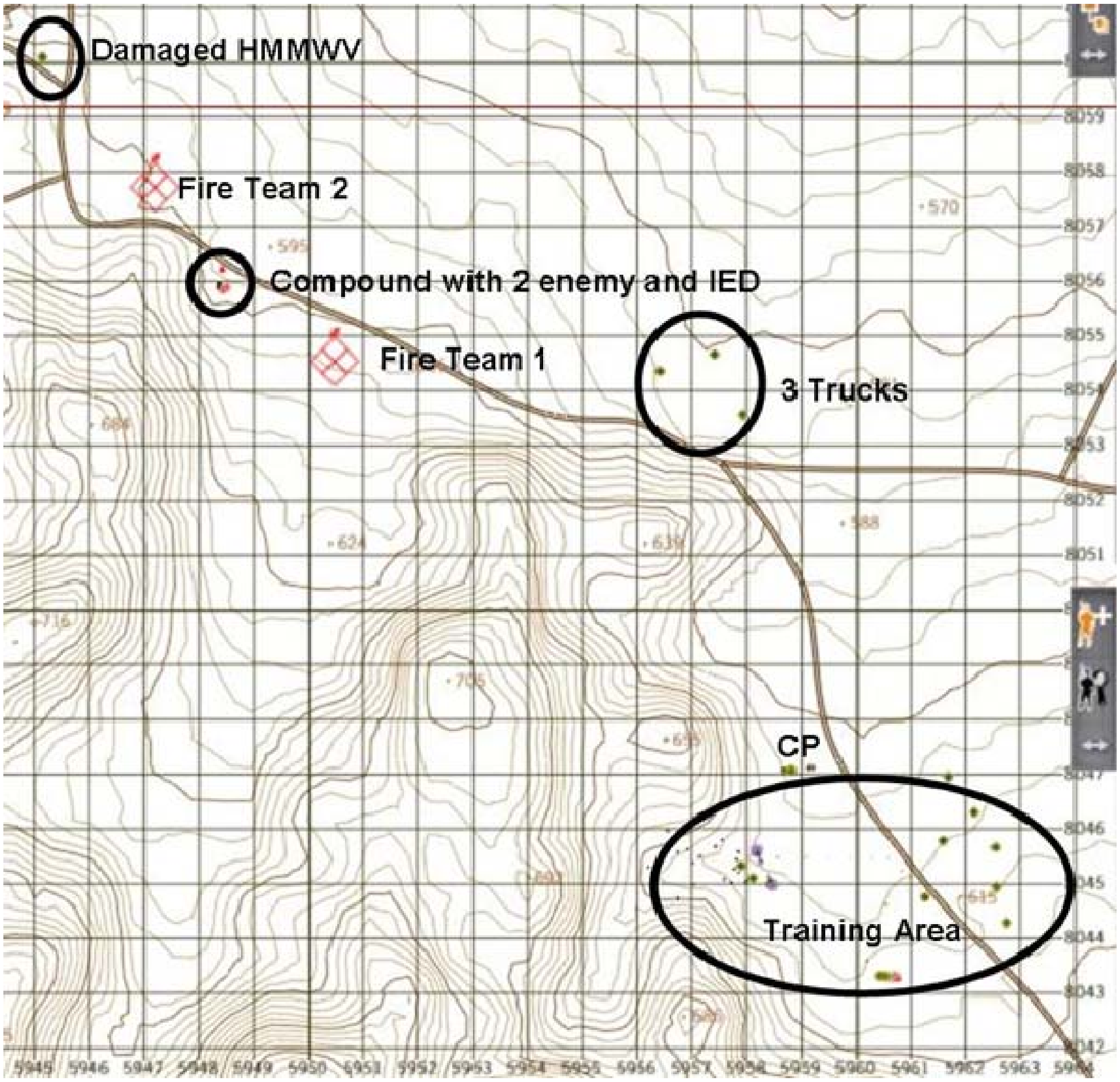

Figure 4. Team evaluation course

In order to assess the degradation of interface skills over time, the project included a follow-up evaluation one week later. The exercise had users shoot an enemy insurgent, drive a vehicle to the body, and load the body into the vehicle. They destroyed an enemy truck with a grenade. Then the users assumed a prone position, shot a target less than 100 meters, and shot a target farther than 100 meters. Users followed the instruction sheet included in Appendix I to keep track of each task accomplished. All participants used identical courses (in design, a prototype course was copied and pasted to make the others) about 200 meters in length in *VBS 2*™'s Samawah terrain database (Figure 5). All users had an instruction sheet that explicitly listed each step of the exercise. Half of the users had the cheat sheet of interface commands from the week before; the other half had no interface assistance.

Figure 5. Individual evaluation course

VBS 2™ offers a robust after action review (AAR) tool for debriefing training exercises. This tool allows the trainer to replay a recorded exercise using a viewing camera that can be positioned anywhere in the scene. The trainer can attach the camera to an object, such as a vehicle, or fly the camera through the scene to any point. The trainer can start, stop, fast forward, and rewind the AAR as required. In this way, a trainer can review any part of a tactical scenario multiple times from multiple positions. The AAR tool includes a timer enabling the recording of specific event durations. The project used this AAR tool for data collection in support of the evaluation.

Participants completed a one-page pre-exercise survey that included demographic information and computer usage profile. They chose one of the twelve simulation computers available in an open classroom. After a brief project introduction, the participants saw the slide presentation and completed the individual training portion of the exercise. They were then informed that they were operating as teams of two and started the vehicle familiarization training. After the personnel and IED recognition, the participants boarded the same vehicle and completed the rest of the training together. They completed the towing training and free practice as described above, proceeded to the command post, and boarded the evaluation MTVR. Participants had ten minutes to complete the evaluation exercise, recorded with the AAR tool. After the exercise finished, participants completed a one-page post-exercise questionnaire that focused on skills that were easy and difficult, memory of interface skills, and a seven-question Likert scaled evaluation of confidence in the basic interface skills. The responses to the basic skills involved a rating from 1 to 5, and we considered a rating of 3 as average for determining the success of the training. The two surveys used for the experiment are included in Appendix H. The complete exercise, including training and evaluation, lasted for a 50-minute class period. The follow-up evaluation occurred one week later, in the first five minutes of the class period.

3. Results

First and foremost, a pilot study serves to identify unforeseen problems in the project methodology. This pilot study accomplished this goal with the following observations. Because of a technical software issue, disarming an IED crashed the AAR tool. For this reason, all participant activity recorded after IED disarming was lost to analysis. The AAR tool shows shots fired on a time bar, so one could determine whether the team fired after the IED crashed the AAR tool even though the IED disarming prohibited viewing this portion of the scenario. Lack of clarity in the instructions resulted in participants driving their HMMWVs instead of the MTVR to the Landrover for the towing training. The HMMWVs could not tow, so the participants did not train that skill, but had a verbal explanation of the towing procedure. Participants tended to assault the insurgent fire teams. Although the enemy objects were set to "never fire," they fired to defend themselves when in imminent danger, resulting in unexpected close-range small arms battles. Finally, in the second session evaluation, one of the participants shot another right at the beginning of the scenario, so that the victim participant was removed from all data collection. These unexpected problems confounded the data collected from the evaluation exercise.

a. Team Evaluation

Three of the six teams completed the full evaluation with a mean time of 7:11 (standard deviation 1:32). Four of the six teams completed the evaluation through the IED station with a mean time of 6:54 (standard deviation 1:30). All six teams engaged and destroyed the three trucks at the first station. Four of the six teams assaulted Fire Team 1 by driving right up to the enemy. As previously described, the artificial intelligence allowed the enemy to defend itself when in imminent danger, resulting in close-quarters battles with Fire Team 1. For this reason, one team lost both members at the Fire Team 1 station and could not continue. Two teams continued the scenario with one member dead; in both cases, the single team member completed the scenario alone.

All six teams eventually followed the correct path as designated by the signs. However, four of the six teams showed signs of disorientation at some point during the exercise. Two of the teams strayed so far from the path that they clearly relied on their maps to navigate back.

As mentioned, three teams did not complete the course. One team did not complete the course because Fire Team 1 killed both members. For the team that completed the course through the IED station, but did not complete the course entirely, one of the team members faced a unique problem. The team member was in the prone position and remained that way. The member could move forward by low crawling, but could not stand. This behavior indicated that the team member had become injured, although it was unclear how this had happened. The member's inability to stand made disarming the IED impossible.

The third team chose to disarm the IED at the compound before engaging the enemy inside and evacuating the casualty. For this reason, the AAR tool did not capture any further action at the compound. However, we could determine that the team fired on Fire Team 2 later in the scenario.

b. Survey Results

The post-exercise survey provided some insight into how participants felt about their training. Participants answered two knowledge questions on the post-exercise survey. Without the aid of the simulation or the cheat sheet, all participants correctly knew how to move their body forward. However, only five of the twelve participants correctly explained how to tow a vehicle. Of these five correct respondents, four were drivers.

Participants responded to two subjective questions about the skill or skills they found most difficult and the skill or skills they found easiest. Nine of the twelve participants found shooting easiest, and two found body movements easiest. Answers to the question about the most difficult task differed considerably and included the following: towing, disarming an IED, driving backward, navigation, confirming targets, unslinging a weapon, and recovering a casualty. A group interview question immediately following the exercise revealed that reported driving problems were associated with towing, because the driver must maneuver around the damaged vehicle and back up to it. The driver has no mirrors or other means to see behind him, so another individual in the simulation must guide him.

Participants responded to a question about their comfort level with each of the interface skills on a five-point Likert scale, with large numbers reflecting the highest degree of confidence in that skill. Figure 6 shows the results for the following six skills: basic body movement, vehicle maneuvering, shooting individual weapons, shooting vehicle heavy weapons, manipulating a casualty, disarming an IED, and towing a vehicle. Participants felt least confident with the casualty evacuation and towing tasks. Review of the AAR tool recordings confirms that these tasks were more difficult than shooting and moving. Confidence ratings exceeded an average of 3.0 for all tasks except towing.

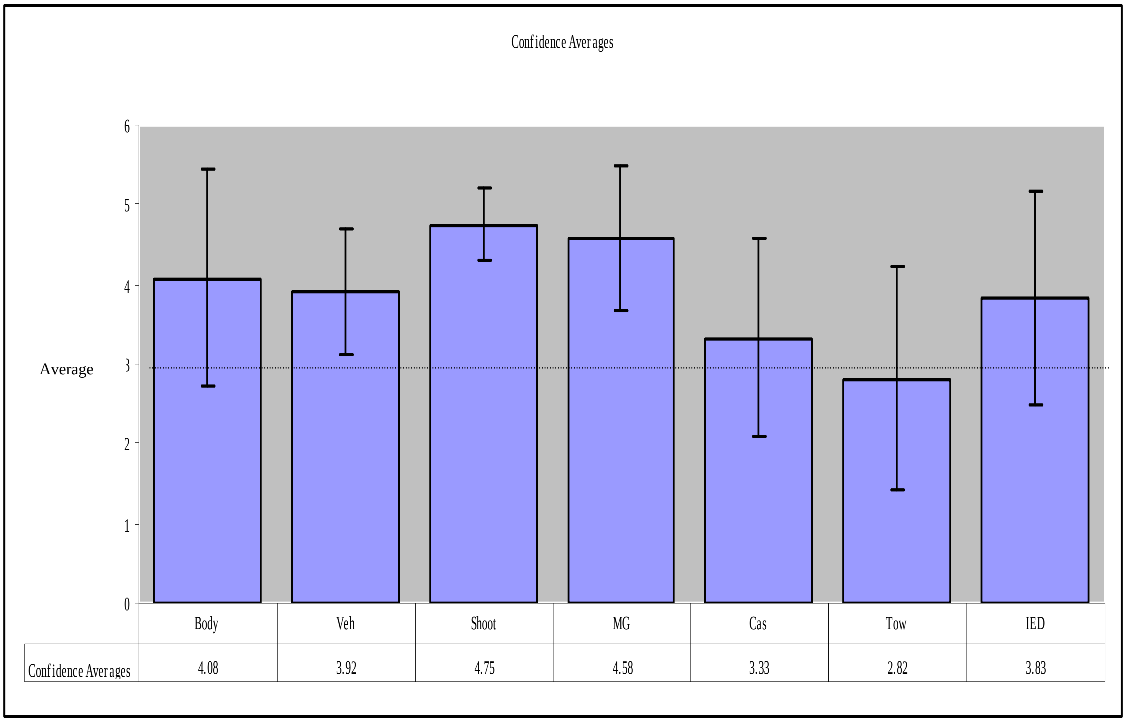

Figure 6. Subjective ratings of confidence in interface skills

c. Follow-on Individual Evaluation

The follow-on evaluation conducted one week later demonstrated considerable degradation of previously taught interface skills. Only eleven participants conducted the exercise, because one participant shot another immediately at the beginning of the exercise, eliminating the victim from further play. Only two of the eleven remaining participants completed the exercise correctly. An additional participant completed all of the events except standing and recording his watch time. He accomplished this in less time than the two who completed the exercise. This participant was a foreign officer and might not have understood the instructions fully to complete the last two events. Ten of the eleven participants shot the first target (the eleventh successfully shot a target, but it was another participant). All eleven participants successfully interacted with the HMMWV. Seven of the eleven participants successfully loaded the casualty into the HMMWV. Only four participants threw a grenade at the truck target, and those four participants also successfully engaged the short and far targets. Five of the eleven participants successfully used their simulation watch to record a time.

During the follow-on individual evaluation, half of the participants had the cheat sheet from the previous week's training, and half did not. Of the four participants who successfully completed the exercise through shooting the far target, two had cheat sheets and two did not. Both the participant who shot another participant and his victim had cheat sheets. The four participants who shot the far target had times of 1:54, 2:23, 2:40, and 5:08.

The follow-on individual evaluation employed robust measures to guide participants through the exercise. Participants had a sheet with all instructions explicitly listed. The course was simple; no other objects cluttered the terrain except the targets for the scenario. Cones provided a maneuver box for each participant. Despite the clear verbal and written instructions and visual cues in the simulation, one participant still managed to get disoriented and confused. Not only did this participant kill another, he drove across another participant's area and loaded the victim in his HMMWV.

d. Practical Tips for Follow-on Work

In addition to determining whether the proposed interface training sufficed, the pilot study provided an opportunity to investigate practical aspects of conducting research with *VBS 2*™. The Marine Corps intends DVTE, including *VBS 2*™, to be portable. The pilot study site was set up for the single class period of the exercise only. We set up the system twice in this project: once for the training session and once for the follow-up evaluation. We conducted an equipment rehearsal prior to the first session of the pilot study, which provided several lessons learned. Based on the equipment rehearsal, we diagrammed the pilot study site with the intent to set up all twelve computers, network them, and run the scenario in a 50-minute period. Our setup script and diagram that resulted from the equipment rehearsal are included in Appendix G. We found that we had all hardware set up and networked within 25 minutes for both sessions. Timing for starting scenarios varies depending on the terrain database that is loaded and the networking arrangement. For example, the Twentynine Palms database requires much more processing power than any of the other installed databases. Because the first session involved six separate environments (one for each pair of participants) and the Twentynine Palms database, we took 15 minutes to get all computers running. With a single environment and the Samawah database for the second scenario, we only required five minutes to start the scenario. In both sessions, with the help of the twelve participants, all twelve computers were shut down and stowed within ten minutes. This timing information is critical for future research efforts that will involve setting up a group of computers and stowing them after the experiment.

During the team evaluation exercise, one participant experienced mild motion sickness and had to stop participation in the exercise for a short time. The participant filled the role of driver. He reported that he had experienced motion sickness in simulators before, and he had used simulations in professional training.

4. Discussion

This pilot study sought to develop a training program that could prepare novice users to properly and efficiently use the *VBS 2*™ interface to conduct tactical convoy operations within 30 minutes. For our survey success criterion, the training resulted in average or above average comfort levels for all skills except towing. Because of the technical problems in teaching the towing task, we eliminated towing from the criteria and concluded that the training met the success criterion. While the pilot study highlighted some concerns that must be addressed for future work, the results of the project confirmed that the scenario and training construct sufficed to familiarize users with the interface. The 30-minute training period can be used for timing planning for future research.

The 30-minute training period most successfully taught the individual skills of moving and shooting, although participants had difficulty cycling between individual weapons in the individual evaluation. The more complex skills of casualty evacuation, towing, and disarming an IED caused the most problems. However, when the participants worked in teams of two, they generally figured out how to deal with these tasks as a team. As a team, participants experienced more trouble with navigation and surviving a threatened enemy in close quarters.

Observation of the trainees throughout the group and individual evaluations indicated that participants had sufficient training but needed more practice. The explanation and demonstration sufficed to give participants a basic understanding of how to use the interface. The cheat sheet provided a sufficient resource to fill in gaps in knowledge for those tasks not exercised regularly. Participants simply needed to practice more to learn the interface and the cheat sheet. Thus, the success of the interface training must be measured relative to what will succeed it. Participants do not complete the interface training ready to be tested in a larger exercise using *VBS 2*™ as an extension of their warfighting skills. However, the interface training prepares them to start working on more complex tactical tasks that would inherently provide the interface practice needed for larger exercises. Estimating the amount of practice necessary to use the interface proficiently is beyond the scope of this project, but this study indicated that the Aussie research team cited in this thesis's background provides a correct estimation of two hours or less for the average user.

The errant participant in the follow-on individual evaluation highlighted the issue of fratricide. Despite the care taken to expose participants to the different types of avatars in *VBS 2*™, one participant did not correctly distinguish friendly targets at close range. This incident suggests further emphasis on the avatar recognition portion of the training.

For future repetitions of this experiment, some means of minimizing the confusion experienced by the errant participant must be devised. Based on this project, two potential solutions suggested themselves. First, the training scenario used a waypoint at the beginning to guide users to the shooting range. The waypoint provides an arrow in the user's screen, indicating the direction he should go. The waypoint also provides a distance to travel. Waypoints should be used to help the participant find his way. Second, the AAR function could potentially help participants. The researcher could conduct the follow-on individual exercise himself, using the AAR to record an example of a correct execution. The researcher could then play this AAR prior to the follow-on individual evaluation to provide the user a visual demonstration of how the exercise should be done. From that point, the participant's only task would be to manipulate the interface to repeat what he had just seen. This visual display may help the user avoid the confusion of the scenario, thereby focusing on the interface tasks.

The unintended problem in the towing training, in which participants moved to the Landrover in the wrong vehicles, provided a valuable comparison study. The towing operation involves steps roughly comparable to loading a casualty into a vehicle. Of all the interface skills, participants were most uncomfortable with towing. Because most participants achieved proficiency in skills of similar complexity, the value of hands-on practice during the training became clear. Having participants follow along in their own simulation environments during the brief appeared to produce better results than a verbal explanation of the procedures.

The empirical data from the study did not demonstrate that participants depended on the cheat sheet. Nevertheless, participants conducted an exercise for fun after the follow-on individual evaluation. All of the participants without the cheat sheet were grateful to get it back for the next exercise. Participants were observed consulting the cheat sheet during the exercise.

A pilot study primarily provides lessons learned for future work. This study highlighted some issues that could endanger a future research effort if not corrected. Specific issues identified in this pilot study include:

- Ensure that IED disarmament does not interfere with AAR recording.
- Brief participants to remain on the road, so they do not provoke the enemy targets to engage them in close-quarters battle. Alternatively, make the enemy targets impotent by reducing their ammunition levels to zero.
- In the towing training, clarify vehicle mounting so that participants use the MTVR.
- Screen for previous simulator sickness, and prepare training units for the fact that some participants may not be able to handle the simulator.
- Brief rules of engagement for the evaluation exercise (that is, engage all targets upon identification).
- Emphasize the key control to raise and lower the rifle.
- On the survey, the computer use question implies the individual's personally owned computer. Divide the question into personally owned computer use, and government and other computer use, to encompass all of a participant's computer time.
- On the survey, make a block for the computer number clearly at the top of the page for clarity.
- *VBS 2*™ offers two modes of operation: user and administrator. Connect participants as users instead of administrators. One participant was able to learn how to use administrator rights to interfere with the conduct of the exercise. Connecting the participants as users also allows the assignment of unique names, which would make data collection much simpler.

Some notable features of the pilot study that worked well deserve consideration in future work:

- The general construct of the presentation combined with hands-on practice worked well for all participants. The familiarity training scenario was constructed well to support the training. The cheat sheet worked well as written.
- The equipment rehearsal provided valuable lessons learned. Had this not been done, a number of potential pitfalls could have jeopardized the pilot study before it even started.

- Two resources supported the researchers setting up the pilot study setting. A script of all the tasks that needed to be accomplished provided explicit instructions for setup. A diagram of the computers and wiring connections accompanied the script. The assistant never consulted the text of the script, but relied heavily on the diagram. Future *VBS 2*™ projects will involve various assistants. More effort should be put into wiring schematics, and the script should not be provided at all.
- For the researcher conducting the study, a script was absolutely necessary. The interface training, group evaluation, and follow-on evaluation, were scripted in detail and well rehearsed. The script and rehearsal were valuable tools to minimize critical errors in the conduct of the study.

In summary, use of *VBS 2*™ as a tactical training tool depends heavily on interface training. Without adequate interface training and experience, Marines will not be able to use the simulation as an extension of their warfighting skills, resulting in unintended problems. While a 30-minute training session does not make a novice into a proficient *VBS 2*™ user, the training suffices to get the person started so that the individual only needs to practice to achieve interface proficiency. Interface training works well if trainees can work hands-on in the simulation during presentation. A brief cheat sheet does not make a user proficient by itself, but provides support when needed. This study provided several practical insights for future work. Key improvements involved technical issues with the AAR tool and connecting computers in user mode. Key successes included the value of preparation and rehearsal and the importance of an exercise script. Finally, the study provided hints into how confused and disoriented a trainee may become in even the simplest of *VBS 2*™ simulations—a consideration that will certainly impact future work.

B. SCENARIO DEVELOPMENT PILOT STUDY

1. Introduction

This section summarizes a second pilot study conducted as part of a project to examine the training effectiveness of *VBS 2*™ to train small unit tactics in a personal computer-based environment. This project involved the testing of a specific small unit tactical convoy scenario. In evaluating the scenario, we sought to determine whether the training improved the participants' appreciation of serious games as a training tool. Furthermore, we investigated whether participants felt that their small unit tactical convoy knowledge and skills improved as a result of the training. These questions served as a first step toward determining whether *VBS 2*™ can provide effective tactical training for military personnel.

a. The Training Exercise That Started It All

At the Marine Corps Air Ground Combat Center (MCAGCC) in Twentynine Palms, the Tactical Training Exercise Control Group (TTECG) administers a series of training scenarios to operational units. The TTECG has developed these scenarios over time against the backbone of the training and readiness system. As a starting point for our scenario development, we observed TTECG operations. TTECG supports a series of exercises packaged under the name Mojave Viper. Marine Corps fleet units, both active and reserve, rotate through Mojave Viper training at the rate of twelve units per year. TTECG exercises are rigidly controlled and evaluated in the effort to provide all units the same training experience and a common evaluation baseline. The Motorized Operations Course (MOC) provides a tactical scenario with four individual stations to test the standard operating procedures, immediate action drills, and small-unit tactics of a platoon-sized convoy (usually between six and eight vehicles).

The first station tests the unit's ability to recognize an IED, secure the area, report the appropriate information to higher headquarters, and link up with forces who will handle the device. The station consists of a vehicle hulk representing a vehicle with an IED inside. The second station requires a unit to react to an exploding IED and a far ambush. The exercise controller causes an explosion (one-pound stick of TNT) and informs the unit that the simulated bomb disabled the lead vehicle. The controller then activates ten personnel targets at long range (350 meters). The participating unit can choose to suppress the targets and maneuver the unit through or suppress the targets and assault. The third station consists of a destroyed enemy battle position with a near ambush consisting of trenches with bunkers and personnel targets. Again, the unit may choose to suppress and maneuver through or assault the targets. Regardless of the drill employed, the controller will assess one or more casualties for the unit to handle. If supporting aviation assets are available, the controller will paint enemy units to the north. Station 4 allows the unit to exercise control of tactical aircraft to destroy two vehicles.

The MOC provides the opportunity for the exercise unit to practice several distinct skills. The unit must execute “fire and maneuver,” the set of skills used to direct and control multiple vehicles to destroy targets while maintaining unit security. All vehicles must practice fire discipline so that all targets get destroyed without expending all ammunition on one target and letting others go free. Internal communications must be correct and effective. The unit must exercise control over intelligence and combat air support assets in a tactically meaningful way. The unit must handle battlefield realities such as casualties and vehicle breakdown. The unit must coordinate its actions with higher headquarters, reporting all significant activity as appropriate. The exercise tests the unit’s understanding and practical application of convoy tactics. The exercise unit demonstrates the ability to conduct the various immediate action drills required for tactical success. Most importantly, the MOC provides an opportunity to scrutinize a unit’s standard operating procedures to determine whether they are really standard, and whether they are truly understood.

In Chapter II, we discussed NAVMC 3500.87, the Infantry Training and Readiness (T & R) Manual, that serves as the basis of all infantry training. The publication codes and lists individual tasks as Mission Performance Standards (MPSs). Using the events of the MOC as a model, we developed a list of individual tasks to train. The T & R Manual summarizes convoy operations into a single platoon collective task INF-MOBL-5150 "Conduct convoy operations." We broke this task down into subtasks that participants could easily evaluate. The T & R Manual supports each of these tasks, although we separated some subtasks for the sake of evaluation convenience. Table 1 shows our final list of subtasks and traces their origins in the T & R Manual.

Evaluated Event in Experiment	T & R Manual Source
React to unexploded Improvised Explosive Device	INF-MOBL-3150 React to an unexploded Improvised Explosive Device (IED)
React to an Improvised Explosive Device detonation	INF-MOBL-3151 React to an Improvised Explosive Device (IED) detonation
Take immediate action against a blocked ambush	INF-MOBL-5155 Take immediate action against blocked ambush during motor march
Take immediate action against an unblocked ambush	INF-MOBL-5156 Take immediate action against unblocked ambush during a convoy
Cordon and 360 degree security	Component event 9 of INF-MOBL-5150 Conduct convoy operations
Employ vehicle machine guns / weapons	INF-WPNS-5308 Conduct heavy machinegun offensive operations
Mounted fire and maneuver	INF-WPNS-5308 Conduct heavy machinegun offensive operations
Shift fires / cease fires	INF-WPNS-5308 Conduct heavy machinegun offensive operations
Vehicle recovery / bump plan	Component events 11 through 15 of INF-MOBL-5150 Conduct convoy operations
Casualty evacuation	INF-MED-5430 Process casualties
Communication with higher headquarters	Component event 7 of INF-MOBL-5150 Conduct convoy operations
Communication between vehicles in convoy	Component event 7 of INF-MOBL-5150 Conduct convoy operations
Communication between personnel in vehicle	Component event 7 of INF-MOBL-5150 Conduct convoy operations

Table 1. Evaluated tasks in convoy training experiments

We did not use the MOC itself in this study, but one must understand the idea of the exercise as background to this work. This exercise provided the inspiration for the scenarios we developed. Also, the MOC inspired the live exercise used as an evaluation mechanism in a follow-on experiment. Our analysis of this exercise included personal observation and detailed analysis of the grading sheet used to evaluate a platoon's performance. The MOC is developed on solid Marine Corps doctrine and tactics, techniques, and procedures. We based the entire body of work discussed in this thesis on a real operational exercise conducted by each unit in the Marine Corps at some point in the training cycle.

b. Background Literature Supports Survey Techniques

The ultimate test of the effectiveness of a serious game as a training tool is improved performance in the real world. However, this approach is not the most practical initial step in the laboratory environment. For this reason, the bulk of the study of serious game effectiveness has involved user self-assessment. The Aussie studies of *VBS 2*™ discussed in Chapter II provide some of the most valuable published insight into the utility of *VBS 2*™ as a training tool. Table 2 summarizes all of the previously referenced Aussie VESL studies. Table 2 highlights a trend in measurement technique across the spectrum of the research work: that is, a consistent use of participant questionnaires to determine how well the simulation worked.

Year	Project	Independent Variable	Dependent Variable	Measurement Technique
Title: *1st-person tactical shooters: COTS games with military training potential?*				
2002	Determine whether *VBS 2*™ had military training potential	None	None	13 question survey of 12 SME's
Title: *Constructing the virtual section*				
2004	Examine decision making techniques employed in game play	Amount of verbal communication Use of roles Awareness of team disposition	Performance	Points scored in game; participant questionnaire
Title: *Factors in team performance in a virtual squad environment*				
2004	Determine the ideal squad size	Size of section	Performance	Loss Exchange Ratio; participant questionnaire
Title: *The use of games to investigate tactical decision-making*				
2005	Examine decision making models employed in game play	Decision making approach	Performance in training scenario	Correlation: decision making by questionnaire, performance by number of win/lose matches won
Title: *Challenging the super soldier syndrome in 1st person simulations*				
2005	Examine the extent of Super Soldier Syndrome in *VBS 2*™	Use of suppression; Use of accuracy / dispersion	Change in game tactics (tempo of movement, use of cover, firing procedure, personal tactics, team tactics)	Points scored in game; participant questionnaire

Title: *Proficient soldier to skilled Gamer: Training for COTS success*				
2005	Determine how long it takes a user to be able to use *VBS 2*™ as an extension of warfighting skills	Time to learn interface	Performance	Pass a "Test of Objectives" Questionnaire asking when participants felt comfortable
Title: *Heart-rate and immersion in a first-person simulation*				
2006	Determine physiological response and sense of presence in *VBS 2*™	Activity (rest, walking, playing different scenarios)	Physiological response and sense of presence	Heart rate with a monitor and 7 question survey
Title: *After action review of simulation results: impact of presentation modality*				
2006	Examine different visualization modalities to enable a commander to effectively use *VBS 2*™ for AAR	AAR presentation modality	Utility of modality	Questionnaire

Table 2. Summary of performance measurement techniques used in Aussie studies

In Chapter II, we discussed two Naval Postgraduate School projects involving serious games. In 2005, U.S. Army Majors J. Nolan and J. Jones used *Delta Force: Black Hawk Down-Team Sabre™* as a small unit tactics training platform at the Infantry Officer Basic Course in Fort Benning, GA. The two researchers compared survey data from a control group who did not use simulation and a test group who used the COTS game to demonstrate that serious games could be used for training (Nolan & Jones, 2005). In 2007, U.S. Marine Corps Major Neil Fitzpatrick and Turkish Army Captain Umit Ayvaz used a similar survey mechanism to determine the effectiveness of a decision-making trainer called *Close Combat Marine* (Fitzpatrick III & Ayvaz, 2007). In both research efforts, user feedback and self-assessment provided the sole basis for effectiveness analysis.

In summary, relevant literature indicates that the first sensible step in determining the effectiveness of a simulation trainer is to test user appreciation of the serious game. Previous work demonstrates how a researcher can leverage survey techniques to gain insight into the effectiveness of the training tool. We proposed to conduct a small unit tactical convoy exercise with *VBS 2*™ and see how participants' perceptions of the serious game and their own tactical skill changed.

c. Research Interests

As a pilot study supporting a larger project, this project served two main purposes. First, as the background literature indicates, progress in future *VBS 2*™ effectiveness evaluation projects requires investigation into user perceptions of the serious game. The larger supported project focused on small unit convoy tactics. Thus, this project started with the development of tactical scenarios and tested them with two user groups. We conducted the scenario testing to gain insight into the following two null hypotheses:

- The use of *VBS 2*™ does not change the appreciation of serious games as a training tool, as measured by the Likert scaled responses of participants.
- Participants feel that the use of *VBS 2*™ does not change their small unit convoy knowledge and skills, as measured by Likert scaled responses.

Second, for planned future projects, groups and teams will use *VBS 2*™ as a common environment to interact toward some unit goal. As in the case of the interface pilot study discussed in the previous section, a lone researcher in a laboratory can only troubleshoot a limited number of issues in support of such a project. Common sense dictates that many unpredicted problems and quirks will arise from group use that the lone laboratory developer can never find by himself.

In this regard, this pilot study served as the first effort in the larger project of having multiple people work together in a common environment.

The TTECG MOC exercise involves Marines patrolling a designated course in six to eight vehicles armed with heavy weapons. The course trains the following core skills: react to an unexploded improvised explosive device (IED), react to an IED detonation, take immediate action against a blocked ambush during a convoy, take immediate action against an unblocked ambush during a convoy, evacuate a damaged vehicle, and evacuate a casualty. We established these skill sets as the core objectives of our simulation training. From these skills, we derived a series of three progressively more difficult scenarios. The pilot study trained participants with these scenarios, comparing their attitude toward serious games and their self-assessed tactical skill before and after the training.

2. Method

a. Participants

We conducted the pilot study in two distinct parts. The first part, Experiment 2, consisted of testing a single convoy scenario in a school environment at the Naval Postgraduate School in Monterey, CA. The second part, Experiment 3, tested all three scenarios with operational Marines from a training command in Camp Pendleton, CA. Experiment 2 served to work out the technical issues in running the scenario, such as testing radio operation, ensuring participants matched with the right avatars in the game, and checking networking ideas for feasibility. Experiment 3 gave Marines with convoy experience the opportunity to comment on the tactical validity of the scenarios and *VBS 2*™ itself. We evaluated both groups for change in attitude toward the simulation and change in self-assessed tactical proficiency.

Experiment 2 was broken into four 50-minute sessions conducted weekly for one month. Twenty Naval Postgraduate School Modeling, Virtual

Environment, and Simulation (MOVES) graduate students, ranging in age from 27 to 41 years, participated in the pilot study. All participants volunteered as part of a seminar program within the curriculum. All the participants were male military officers with service times ranging from 4 to 24 years. Three foreign officers participated, and U.S. officers represented all four of the armed services. The first session provided training on the use of the *VBS 2*™ interface focusing on the following tasks deemed applicable to the convoy scenarios: individual body movements, manipulation of personal gear, use of personal weapons, vehicle interaction and operation, use of vehicle weapons, manipulating a casualty, towing a vehicle, disarming an IED, and recognition of friendly, civilian, and enemy avatars. The second session provided a short 20-minute overview of convoy tactics. Participants then had a 15-minute practice period to practice mounting vehicles in the assembly area, forming into march formation, tactical movement in a benign environment, and control of fires on a target array. During the third and fourth sessions, the participants conducted a tactical convoy scenario.

We conducted Experiment 3 in a full day of training on site at Weapons and Field Training Battalion (WFTBN) San Diego in Camp Pendleton, California. Our training schedule for the day is included in Appendix K. Twenty-four Marines, ranging in age from 19 to 29 years, participated in the study. Unit leadership randomly selected eight Marines from each of the three companies for participation in the training. The battalion conducts marksmanship and field training for recruits, so approximately two-thirds of the participants were infantry, and the other third were support personnel including communicators, armorers, and supply and administration personnel. The training group consisted of one Private (E1), one Private First Class (E2), three Lance Corporals (E3), nine Corporals (E4), nine Sergeants (E5), and one Staff Sergeant (E6). The rank structure provided us the ability to structure the personnel like a typical Marine platoon, although the Marines had not operated together before. We chose WFTBN because of the combat experience of the Marines in the unit. WFTBN is a garrison training environment that serves as an opportunity for Marines to get a break from heavy operational deployment cycles in the fleet forces. Only five of the Marines had never been to combat. Eighteen Marines had participated in convoy operations in combat, and twelve Marines reported more than 100 personal convoy operations in combat. As a group, the WFTBN Marines were Subject Matter Experts in the tactical skills included in this study. The second study included the same exercise progression as the first. Marines started with the basic interface training and then moved on to the progressively more difficult tactical convoy scenarios.

b. Apparatus

The project used twenty Dell Precision M6300 laptops from a suite of the Marine Corps Deployable Virtual Training Environment (DVTE) package. Computers were networked using D-LINK DGS-2208 8 port switches. Peripheral equipment, including mice, cables, and switches came from the standard DVTE package.

We used a standard classroom for Experiment 2 with the MOVES students. For the familiarization training and evaluation, we networked the computers in pairs with four computers per switch. Paired users faced each other at a classroom table so that they could not see each other's screens. For the convoy exercises, we connected the computers on a single network with six computers per switch. Participants sat in classroom seating in a theater-style classroom. The three members of each truck crew sat in a row, but were dispersed so that they could not see each other's computer screens. The diagram of the room setup is included in Appendix J. Participants communicated using the Joint Virtual Tactical Radio (JVTR), a voiceover IP system. JVTR allows the use of two communication nets, so vehicle commanders communicated on one net, while the other net was used as a vehicle intercom for the truck crew to communicate. Figure 7 shows the setup of the room for the convoy exercises.

Figure 7. Tactical convoy training at the Naval Postgraduate School

For Experiment 3 conducted at WFTBN, we used a long, narrow classroom in the unit's academic building. The facility featured overhead projection support and had more than enough room for the twenty-four participants to spread out. We used about half of the room's individual desks and interspersed them around the room to seat participants in three-person groups with maximum space between groups. We used a setup similar to the MOVES study with computers networked at five to eight per switch, depending on the physical locations of the machines. Generally, participants could not easily see each other's screens, although the setup did not prohibit the determined Marine from doing so. We used the same system for JVTR communications that we used in the MOVES study, with two radio nets supporting vehicle and convoy communications, respectively. Figure 8 shows the WFTBN training site.

Figure 8. Tactical convoy training at WFTBN, San Diego

c. Procedure

We used a similar experiment procedure for both the MOVES and WFTBN experiments. Before the tactical scenario training, participants completed a two-page questionnaire, included in Appendix L. The questionnaire included demographic and computer usage information. This questionnaire also included a set of questions intended to determine the participant's attitude toward personal computer-based simulation training. Another set of questions determined the participants' perception of tactical skill. Responses to both sets of questions were recorded on a 5-point Likert scale. After the tactical scenario training, participants completed a three-page post-exercise questionnaire, included in Appendix N, that featured subjective questions about the effectiveness of the training. The simulation attitude questions and tactical proficiency questions from the pre-exercise questionnaire were repeated in the second questionnaire. Comparison of these Likert scaled responses served as the basis of analysis for this project.

We wanted to evaluate an academic test for later use, and we administered the test to the WFTBN group. We developed two similar tests with eighteen multiple choice questions each. The questions related to the general tactical areas of reaction to ambush, reaction to IED, casualty evacuation, and vehicle recovery. Each of the questions had four choices for an answer with one best answer. We developed the tests from the training materials administered for convoy classes at TTECG in Twentynine Palms and The Basic School in Quanico, VA, that trains all Marine Corps junior officers. We designed the tests to be similar but different with paired questions. For example, a reaction to ambush question on one test would have a similar question on the other test. The Marines took one of the tests before training and one after training. We randomized the test taken first, with half taking one of the tests first and the other half taking the other test first. We included both tests in Appendices P and Q.

For all tactical scenarios, participants were grouped in teams of three: a vehicle commander riding in the passenger seat, a driver, and a gunner for the vehicle's weapon system. Seven vehicles participated in the MOVES exercise, and eight vehicles participated in the WFTBN exercise. The vehicles consisted of a mix of five HMMWVs and two MTVRs armed with an even mix of 0.50 caliber machine guns and MK 19 40 mm grenade launchers. Each tactical scenario consisted of a series of stations, including reaction to an inert IED, vehicle recovery, reaction to an unblocked ambush, casualty evacuation, and reaction to a blocked ambush. The scenarios used the game's Twentynine Palms database and involved operation in the western Quackenbush area of the terrain. The scenarios varied from roughly 20 kilometers in length to a scenario involving more than 40 kilometers of the western side of the Twentynine Palms training area.

For analysis, we used statistical group comparison techniques including the paired t-test and the Wilcoxon rank-sum method. For all statistical tests, we used an alpha level of 0.05.

3. Results

First and foremost, this pilot study served to identify unforeseen problems in the project methodology. This pilot study accomplished this goal with the following observations:

- Some users failed to take training seriously (negligent discharges / fratricide). This degraded the experience for the whole group, not just the individual. This problem was much more pronounced with the WFTBN group.
- Communication was a burden as *VBS 2*™ has no internal communication tool.
- Computer glitches hindered the commencement of training.
- 12 computers = 1 man-hour setup + 1 man-hour startup + 1 man-hour breakdown; It takes a working knowledge to set up the system and run the program correctly

While these unexpected problems confounded the data collected from the evaluation exercise, the survey results provided valuable feedback.

a. Survey Results

The post-exercise survey implied that *VBS 2*™ had little training value as far as both MOVES students and WFTBN Marines were concerned. MOVES students, having little to no convoy experience, suggested that learning immediate action drills was the only value provided by the game. The Marines, when tested, suggested the same thing. While the sample was relatively small and the Marines used for the exercise were part of a training battalion, over half of the Marines used were from the infantry occupational specialty. Also, most of the Marines had average to extensive convoy experience and could be considered “Subject Matter Experts” in convoy standard operating procedure and immediate action drills. When the entire sample of post-exercise results was evaluated, there appeared to be no significance that would lead to rejecting either hypothesis, implying that there was no training value in using *VBS 2*™. However, when the data of Marines with little to no convoy experience was separated from the whole to more closely mirror the sample from the NPS trials, we found significance in some of the immediate action drills just as we did from the MOVES students.

b. Academic Knowledge Test Results

Only the WFTBN study involved the administration of the academic knowledge test. In this endeavor, we wanted to ascertain whether the test made tactical sense to our pool of Subject Matter Experts. We did not give consideration to the results of the academic knowledge test as an indicator of the potential effectiveness of the simulation training in this study because we did not design the study to improve academic knowledge of convoy operations. Rather, the study served to determine whether the scenarios we had developed met our technical and tactical expectations. With this in mind, our analysis of the academic knowledge test results did not focus on change in performance. Instead, we concerned ourselves with the fairness of the test, and whether the administration of the test produced data that could be analyzed in later studies.

We recorded the results of the test in a spreadsheet. If Marines answered questions incorrectly, we recorded the incorrect response in the corresponding spreadsheet cell. With this data, we not only examined how many Marines missed each question, but whether the questions were answered incorrectly with consistent responses. In this way, we could generally group questions into three categories: questions that were answered correctly, questions in which Marines could not agree on an answer (incorrect and inconsistent answers), and questions in which Marines as a group disagreed with our answer (incorrect, but consistent answers). The last two categories of questions differed. Incorrect and inconsistent answers indicated that Marines did not understand the material addressed by the question. Incorrect and consistent answers indicated that the Marines as a group had an understanding of the question but looked at the issue differently than we intended. Most likely, this final problem suggested a problem with the wording of the question.

Tables 3 and 4 summarize the data from the knowledge tests. We started by highlighting questions that we considered a problem, and we used a criterion of less than 60% of the Marines answering the question correctly. Using this idea, we noted that Test 1 had six problem questions while Test 2 had eight. Next, we analyzed the responses to look for problem questions that may have resulted from unclear wording. We noted that Question 4 from Test 1 and Questions 3, 13, and 16 from Test 2 particularly fit in this category. These four questions were noteworthy because they all related to organization of the convoy and division of labor within the convoy organization.

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Number respondents for each answer						*Yellow highlight indicates the correct response*												
A	0	3	8	14	21	15	2	6	3	21	7	2	4	0	22	20	5	7
B	20	10	1	4	2	3	4	1	10	0	15	5	8	1	1	1	9	4
C	0	3	4	3	1	0	1	2	5	0	1	13	5	18	0	1	5	0
D	4	7	10	2	0	6	17	15	6	2	0	2	5	4	0	1	4	11
Other	0	1	1	1	0	0	0	0	0	1	1	2	2	1	1	1	1	2
Percentage for each question						*Yellow: no concern, red: concern (criteria 60%)*												
A	0.00	0.13	0.35	0.61	0.88	0.63	0.08	0.25	0.13	0.91	0.30	0.09	0.18	0.00	0.96	0.87	0.22	0.32
B	0.83	0.43	0.04	0.17	0.08	0.13	0.17	0.04	0.42	0.00	0.65	0.23	0.36	0.04	0.04	0.04	0.39	0.18
C	0.00	0.13	0.17	0.13	0.04	0.00	0.04	0.08	0.21	0.00	0.04	0.59	0.23	0.78	0.00	0.04	0.22	0.00
D	0.17	0.30	0.43	0.09	0.00	0.25	0.71	0.63	0.25	0.09	0.00	0.09	0.23	0.17	0.00	0.04	0.17	0.50

Table 3. Analysis of respondent answers to Academic Knowledge Test 1

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Number respondents for each answer							*Yellow highlight indicates the correct response*											
A	5	6	15	10	4	0	1	1	18	18	2	4	14	4	5	22	13	0
B	3	16	3	6	12	21	3	19	2	0	1	6	1	5	1	1	3	9
C	14	1	2	6	3	0	2	0	2	2	16	12	1	13	2	0	2	2
D	1	0	3	1	4	1	17	3	1	2	4	0	5	1	15	0	5	12
Other	1	1	1	1	1	2	1	1	1	2	1	2	3	1	1	1	1	1
Percentage for each question							*Yellow: no concern, red: concern (criteria 60%)*											
A	0.22	0.26	0.65	0.43	0.17	0.00	0.04	0.04	0.78	0.82	0.09	0.18	0.67	0.17	0.22	0.96	0.57	0.00
B	0.13	0.70	0.13	0.26	0.52	0.95	0.13	0.83	0.09	0.00	0.04	0.27	0.05	0.22	0.04	0.04	0.13	0.39
C	0.61	0.04	0.09	0.26	0.13	0.00	0.09	0.00	0.09	0.09	0.70	0.55	0.05	0.57	0.09	0.00	0.09	0.09
D	0.04	0.00	0.13	0.04	0.17	0.05	0.74	0.13	0.04	0.09	0.17	0.00	0.24	0.04	0.65	0.00	0.22	0.52

Table 4. Analysis of respondent answers to Academic Knowledge Test 2

c. Analysis

The design of the paired before and after surveys dictated an analysis of paired Likert scale responses. That is, we looked at the differences between numerical responses to the attitude questions and skill sets for changes in attitude or proficiency. We first analyzed the survey data to find any linear dependence (multicolinearity) between the survey questions that would indicate that the answer to a specific question would influence the answer to one or more others. To evaluate this we used a pair plot of the responses to all questions on the “after” survey, as shown in Figure 9. Not surprisingly, this pair plot showed a strong linear relationship between all four questions which indicated that they together shared some attribute(s) of the serious gaming that the participants felt would be valuable in unit training. We found similar linear relationships to be strong in other questions pertaining to self-assessment.

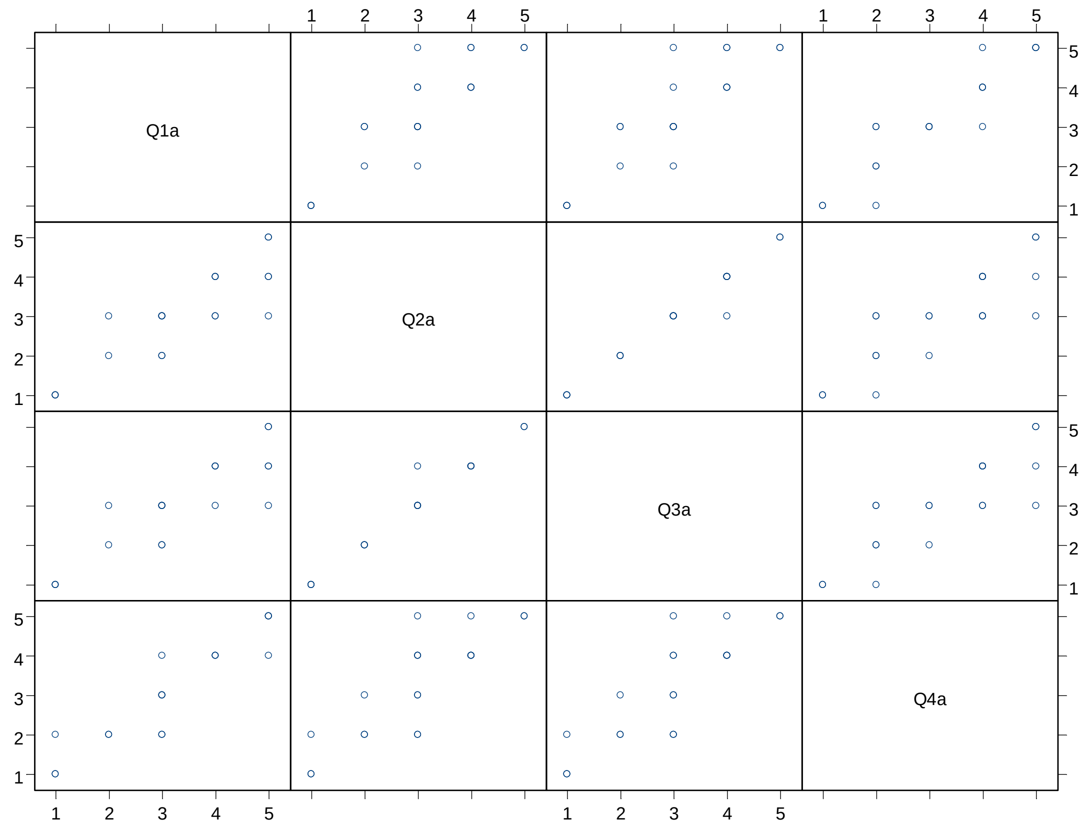

Figure 9. Pair plot of survey questions related to user appreciation of simulation training

Next, we used a Wilcoxon Rank test to determine which responses had changed with statistical significance. For the MOVES students who trained in the first part of the study, we found three tactical skills to have significance as shown in Table 5. The MOVES students, representing untrained personnel in a non-Marine setting with respect to convoy experience, responded that *VBS 2*™ improved knowledge and ability of immediate action to an unblocked ambush, cordon and 360° security, and casualty evacuation.

#	Question	z	p-value
4	Unblocked Ambush IA	-2.9266	0.0017
5	Cordon and 360 degree security	-2.0991	0.0179
10	Casualty evacuation	-2.1297	0.0166

Table 5. Self-assessment questions that showed a significant difference in response for MOVES students

When we conducted the similar exercise at WFTBN and a group of Marines with mixed convoy experience was tested, we found three tactical skills to have significant change, as shown in Table 6. None of the skills was common to those that showed significant change in the MOVES group. It is important to note that these results were only significant for Marines who had little or no convoy experience. The Marines who had more than twenty-five convoys found that the training provided little or no value and actually degraded their self-assessed performance in some cases.

#	Question	z	p-value
1	React to unexploded IED	-2.1503	0.0158
2	React to detonated IED	-2.0827	0.0186
6	Employ weapons	-2.1333	0.0164

Table 6. Self-assessment questions that showed a significant difference in response for WFTBN Marines

4. Discussion

a. Initial Findings

The series of initial pair plots revealed strong linear relationships among aspects of the game experience, as well as the participants' assessment of their level of skill and familiarity with convoy tactics. These strong linear relationships led us to investigate what aspects of the game, or tactical skills, affected the Likert scaled responses most. Having had each participant answer detailed pre- and post-training surveys, we then made a data set that enabled us to review how the delta of each question was affected by the training.

The Wilcoxon Rank tests showed that *VBS 2*™ did not significantly change participants' attitudes or appreciation of serious gaming. This is an interesting, if not surprising, result, given that the relative youth of our participants did not translate into excitement or increased appreciation for serious gaming. The resulting p-value of this assessment meant that there was no basis to reject our first null hypothesis: The use of *VBS 2*™ does not change the appreciation of serious games as a training tool as measured by the Likert scaled responses of participants.

b. Digging Deeper

The failure to reject our first null hypothesis did not necessarily mean that *VBS 2*™ was devoid of any benefits toward training. We examined self-assessed proficiency to determine if participants felt that their tactical abilities had changed even if their opinion of simulation as a training device had not. Knowing that our participants would have various military skills, experiences and time in the military, we structured the pre- and post-training surveys to incorporate these factors. By cross-examining military experience with questions that elicited our participants to assess their personal proficiency in immediate action drills (such as their confidence/ability to take action against a blocked ambush), we obtained two revealing solution sets to Wilcoxon Rank tests:

- MOVES students who reported themselves as having little convoy knowledge and experience reported that *VBS 2*™ improved their knowledge, ability and confidence to take immediate action in the cases of an unblocked ambush, cordon, and establish 360° security and conduct casualty evacuation.
- Among the operational Marines who participated in the testing at WFTBN, those who reported having no practical convoy experience felt that *VBS 2*™ improved their knowledge, ability and confidence to take immediate action in the cases of an unexploded IED, detonated IED, and in the tactical employment of weapons.

These tests suggest that *VBS 2*™ might be an effective introductory training tool for those who have little or no convoy experience. Where actual convoy rehearsals and training may be difficult or burdensome, *VBS 2*™ seems to be a clear alternative to expose junior Marines to training at the schoolhouse or first duty station.

We examined the six skills for which participants identified an increase in self-assessed proficiency. We could find no reason that would explain why the MOVES group showed a change in three skills and the WFTBN novice users showed a change in three separate skills. The groups certainly differed, but the differences did not relate to the skills in any way. From observation of the training in progress, we offer that participants might tend to indicate a change in self-assessed proficiency for the exercises that go well. Some of the exercises experienced difficulties, such as communications problems, computer glitches, and internal command and control problems. On the other hand, other parts of the exercise went smoothly so that standard procedures were executed as intended. We suggest that the particular skill assessed as improved might relate more to what goes well than to any other factor. If novice trainees see a smooth execution, then they may feel more proficient in that particular skill.

c. Applicable for Even the Veteran Marine

For the veteran Marines who reported that *VBS 2*™ may have actually degraded their skill or confidence in their convoy ability, we recommend further study and/or examination of the following factors:

- *VBS 2*™ was not employed in the context that a veteran Marine might see with his actual unit. Such a future occasion might entail them virtually driving the same convoy route prior to the actual convoy, where speeds, terrain features and distances would all serve as useful, albeit virtual, exposure to the actual route. This, in essence, would afford them to "conduct the convoy prior to conducting the convoy."
- Those who reported a degradation in skill may have actually only been made aware of their "rustiness" or inflated sense of personal mastery of what it is to conduct a convoy. In this sense, perhaps *VBS 2*™ serves as a very useful reality check.

To this end, the results of the extended study of the responses to the pre- and post-training surveys led to our conclusion that, in certain cases, we could reject our second null hypothesis. Participants feel that the use of *VBS 2*™ does not change their small-unit convoy knowledge and skills as measured by Likert scaled responses. The instances where the Wilcoxon Rank tests yielded p-values supporting such rejection of the null hypothesis can be summarized as those involving either novice convoy trainees or exposure to immediate action drills.

d. Practical Tips for Future Studies

VBS 2™ is one of many in a wide spectrum of serious games that have either already been fielded or are currently in development. The use of *VBS 2*™ and other similar serious games as a device to expose junior servicemen to tactical scenarios is clearly fertile ground for further study.

In addition to determining how *VBS 2*™ affected participant knowledge and confidence, these two studies also provided an opportunity to investigate the practical aspects of conducting training using the DVTE suite.

The Marine Corps intends DVTE, including *VBS 2*™, to be a portable resource for every infantry battalion. Because *VBS 2*™ is intended to be a portable resource, we found that it will be imperative to every unit to appreciate the following:

- Participants must take the training seriously. Negligent discharges and fratricide severely hinder the effectiveness and spirit of the training.
- The length of training and the days on which it is scheduled (WFTBN training occurred on Friday) ought to be carefully considered to enable participants to more fully focus on the training at hand.
- The current communications package (JVTR) is a burden. Possible replacement, enhancements, or unit workarounds need to be considered. The optimal solution is an internal communication package within *VBS 2*™ itself.
- A larger library of terrain needs to be developed quickly. Areas such as Twentynine Palms need improved fidelity. The size of the Twentynine Palms database makes it unwieldy. For small unit tactical exercises, fidelity is more important than terrain size.
- The computers' operating systems have recurring glitches that will need to be recorded in order to develop patches or user-level workarounds that will support continued training.

e. Conclusion

The objective of this research was to evaluate user perceptions of the serious game *VBS 2*™. As a pilot study, it was also the first effort in having multiple people work together in a common virtual environment. We met both objectives and, moreover, conclusive data led us to the fact that in this case, a broad hypothesis could not be applied to our diverse sample population. Through data analysis and cross-examination of several key factors (i.e., age, rank, convoy experience), we were able to determine that the perceived effectiveness of *VBS 2*™ as a training tool was much larger than a single Likert scaled response. In fact, as a training tool, it holds the potential to be applicable to junior and veteran servicemen alike, albeit in different ways.

IV. EXPERIMENT IN SUPPORT OF HYPOTHESIS 1

A. INTRODUCTION

Experiments 1, 2, and 3 prepared us to use *VBS 2*™ to train Marines. Experiment 1 demonstrated sound practices to familiarize users with the *VBS 2*™ interface so that they could use the simulation as an extension of their warfighting skills. Experiments 2 and 3 provided a forum to test scenarios to determine what worked and what did not. Armed with this information, we could address the questions of this thesis project. With this in mind, we designed Experiment 4 to address the first thesis research question:

- Does preliminary training with *VBS 2*™ positively impact performance in a platoon-level tactical scenario?

In our consideration of the task of training convoy operations with virtual environments, we noted that different approaches could influence the effectiveness of the training. A study at the Israeli Air Force flight school in 1993 inspired our choice of approach. In that study, cadets used a computer game called *Space Fortress II* in the early stages of flight training. One group played seven part-task games, one at a time, receiving feedback after each. The other group used a full mission game with all tasks covered in the same game. A control group trained with traditional techniques. The study found that both simulation groups performed better in subsequent real-world flights than the control group, and the part-task group outperformed the full mission group (Gopher et al., 1994). For our work, we considered two different arrangements of the skill sets to be trained. In one application, a Marine trained each skill individually in depth, presenting progressively more difficult training for each skill individually before moving to the next skill. The second approach combined all the skills into a single training evolution and developed progressively more difficult training for all the skills as a group. We were interested in whether one of these approaches would produce better results, so we developed the second research question for Experiment 4:

- Is there a difference between using a full mission approach versus a part-task approach to training when using *VBS 2*™ for platoon-level tactical training?

In considering the design of this experiment, we relied heavily on previous student work at the Naval Postgraduate School. The previously mentioned work of U.S. Army Majors J. Nolan and J. Jones with Delta Force: Black Hawk Down-Team Sabre™ served as a basis for studying how gaming technology could support training goals (Nolan & Jones, 2005). Likewise, Marine Corps Major Neil Fitzpatrick and Turkish Army Captain Umit Ayvaz worked with a decision-making trainer called *Close Combat Marine*, and their work provided insight into Best Practices for leveraging surveys and questionnaires to gain insight into user performance (Fitzpatrick III & Ayvaz, 2007). We summarized the body of work done by the Aussie Virtual Environments & Simulation Laboratory (VESL) with *VBS 2*™ in Chapter II of this thesis. All of these research efforts directly contributed to the design of Experiment 4.

In fact, Experiment 4 is similar enough to some of these previous efforts that it may seem like just another repetition of the same work. For Experiment 4, we felt it was crucial to conduct the study with an operational unit preparing for real-world contingencies. We sought to take the personal computer-based game beyond the walls of the schoolhouse and the clear-cut environs of the university laboratory. Experiment 3, with its work with infantry Marines at Weapons and Field Training Battalion, demonstrated that enlisted Marines with a “day job” in the operational forces might perceive personal computer-based game training differently. For this reason, we expended much effort to establish an experiment in the operational forces. With this in mind, two competing factors drove Experiment 4: the scientific rigor associated with any hypothesis test and the training needs of an operational unit very much involved in preparing to fight a real-world war. Throughout the research project, we placed equal emphasis on both concerns. That is, we sought soundly and scientifically to gain insight into the thesis question at hand, but we also sought to train Marines as best we could with the tool used for the study. These Marines needed the training we offered, and failure to provide it was unacceptable.

We chose a reserve Marine infantry battalion preparing for deployment to combat theater for Experiment 4. In part, timing drove this decision, because this particular battalion happened to be in the preparation phase at the right time for this research project. However, other factors drove this decision as well. Reserve Marines typically do not enjoy the benefits of simulation available to active duty Marines. Reserve units dot the U.S. map with no regular proximity to active duty training installations. While reserve units are eligible for the Deployable Virtual Training Environment (DVTE) described earlier, they have a lower priority for the equipment than their active duty counterparts. In fact, this particular unit had been working to get the gear prior to their deployment, but at the time they left home site, no DVTE equipment had been used. Because reserve units come from a single geographic location, they typically enjoy better personnel stability than active duty units. Additionally, reserve Marines often stay in the same platoons and companies for their full enlistment, and some may spend entire careers in the same unit. We viewed this unit cohesion as a positive contributor to our research plans. This symbiotic relationship of a unit with a training need and a research project with a need for a unit promised mutual benefit.

In the end, we developed an experiment design that was a compromise result of the competing needs of science and operational training. We conducted our research with one of the battalion's infantry companies. We conducted the simulation training at a phase in the battalion's pre-deployment preparations in which the unit had deployed from home site to Camp Pendleton, California. We had a week of training "white space," or otherwise unobligated training time, to conduct training in support of our project. During this week, platoons conducted training in support of the study for four hours per day for a four-day training week.

The particular company selected for the research had a live exercise aboard Camp Pendleton scheduled that would serve as an evaluation metric for the study. Within these parameters, we developed Experiment 4 using lessons learned from the work mentioned above.

B. METHOD

1. Participants

The Weapons Company of the reserve infantry battalion participated in Experiment 4. For convoy operations, the Weapons Company was already divided into three Motorized Assault Platoons (MAPs), and these MAPs served as the three treatment groups for the experiment. A Marine Corps Weapons Company includes infantry with a variety of specialized skills, including heavy machine guns, anti-tank missiles, medium mortars, and other heavy weapons organic to an infantry battalion. Many of these weapons, such as the 0.50 caliber machine gun, the MK 19 automatic grenade launcher, and the Tube-launched Optically-tracked Wire-guided (TOW) missile are often vehicle-mounted for infantry battalion operations. Therefore, mounted operations, including the convoy mission of moving men and materiel from one place to another, were standard routine training objectives for the Weapons Company. Moreover, proficiency in this domain would certainly be a demand upon deployment to combat theater.

Most of the Marines in each MAP were infantry, including machine gunners (MOS 0331), mortarmen (MOS 0341), and anti-tank missilemen (MOS 0352). However, at the time of the experiment, the ranks of the infantry battalion were being fleshed out with a detachment from a communications battalion, so each MAP had a few communicators, including field radio operators (MOS 0621) and ground communications repairmen (MOS 2844) sprinkled into the platoon organization. Each MAP varied in size, but twenty-four Marines from each MAP participated in the study. Unit leadership randomly chose these Marines with no input or cognizance on the part of the research team. The unit emphasized intact vehicle crews participating in the study so, for the most part, the participants were vehicle crewmembers identified at home site by the Company Commander well prior to the execution of the experiment. With this in mind, we assumed that there were no biases in the selection of the training audience; rather, the Company Commander crafted the training audience from the stable crews early in the planning process.

Each MAP had a Lieutenant serving as the Platoon Commander, and for Experiment 4, these Marines served as the trainers. In this capacity, they organized the participants, supervised exercise briefing, participated in using the simulation exercise to meet specific platoon and company training goals, and conducted the debriefing after each exercise. The Platoon Sergeant for each MAP, the senior enlisted Marine in the unit, did not participate in the training. All three MAPs were larger than the 24-man training audience accommodated in the virtual training, so the Platoon Sergeant handled the Marines who were not being trained in the experiment. Each MAP had an enlisted Marine who served as the Convoy Commander for the exercise. For MAPs 1 and 2, the Convoy Commanders were senior Sergeants (E-5), and for MAP 3, the Convoy Commander was a junior Staff Sergeant (E-6).

Most of the Marines who participated in the study were young Lance Corporals (E-3). Excluding the aforementioned Convoy Commanders, MAP 1 had three noncommissioned officers (NCOs); MAP 2 had six NCOs; and MAP 3 had six NCOs. The average age of the participants was 23.8 years. Using Analsyis of Variance (ANOVA) and paired t-tests, we noted that there was a difference in age between MAPs 2 and 3 (p-value = 0.0164) with MAP 2 having a mean age of 22.75 years and MAP 3 having a mean age of 25.3 years. This difference arose from a few individuals and was not a platoon-wide trend. While no one in MAP 2 had reached their 30s, MAP 3 had a 31-year-old Staff Sergeant and a 35-year-old Sergeant who swayed the average. The mean time in service for all participants was approximately three-and-a-half years and the mean time in unit was approximately two years. There was no significant difference in platoons for these attributes.

2. Apparatus

The project used twenty-six Dell Precision M6300 laptops from a suite of the Marine Corps Deployable Virtual Training Environment (DVTE) package. As in previous experiments, computers were networked using D-LINK DGS-2208 8 port switches. Peripheral equipment, including mice, cables, and switches, came from the standard DVTE package. Unlike Experiments 2 and 3, the network configuration for the familiarization training was the same as for the training exercises. We networked all twenty-six computers together using seven switches, allowing all machines to participate together in the same environment.

The Weapons Company occupied barracks in Camp Pendleton so that they had access to a parade deck and large classroom. We set up the twenty-six computers in the classroom, networked them, and left them configured for the week. The classroom was a large facility configured for press briefings so that we had easy access to overhead projection and power at individual seats. We used the back six rows of tables in the room. Each table row had eight seats, and we used the seats to maximize the space between participants as much as possible. The three participants in a vehicle crew sat in a single row, with two rows having two vehicle crews (six computers) and the remaining four rows having a single vehicle crew each. For the majority of the training, the trainer and exercise controller each had a computer and sat facing the Marines conducting the exercise. In this way, both the trainer and the controller could monitor the virtual action on the screen while observing the action of the participants in the room. Figure 10 shows the room configuration.

Figure 10. Simulation training site for operational unit at Camp Pendleton, CA

As in Experiments 2 and 3, participants communicated using the Joint Virtual Tactical Radio (JVTR), a voiceover IP system. From the lessons learned in Experiments 2 and 3, we attempted to reduce the complexity of the communications problem by using only a single radio net. Only the vehicle commanders used the radio to talk on a single net. The trainer monitored the platoon traffic using his computer and participated as higher headquarters on the platoon's single tactical net. Participating Marines were taught nothing about the radio's operation except how to push a key to talk.

The control group conducted training consisting of sand table exercises and garrison rehearsals. This platoon used the ample sandy areas outside the barracks for sand table exercises. They conducted garrison rehearsals using the unit's vehicle on the parade deck outside the barracks. The platoon commander controlled the exercises.

As mentioned for Experiments 2 and 3, Marines typically operate vehicles in teams of three: a vehicle commander riding in the passenger seat, a driver, and a gunner for the vehicle's weapon system. For all tactical scenarios, we grouped participants in this way. Eight vehicle crews participated in the exercise. The vehicles were all HMMWVs with a mix of 0.50 caliber machine guns, MK 19 automatic grenade launchers, and TOW missiles that reflected how the MAPs trained in the real world according to unit rosters.

As in Experiments 2 and 3, we used statistical group comparison techniques including the paired t-test for analysis. For all statistical tests, we used an alpha level of 0.05.

3. Procedure

As in Experiment 3, the experiment focused on training four tactical convoy tasks: reaction to an IED, reaction to ambush, vehicle recovery, and casualty evacuation. We chose to evaluate the effectiveness of the training in three separate domains. First, a set of knowledge tests was used to determine if the training affected participants' academic knowledge of the skill sets. Second, surveys were used to determine how participants assessed their own proficiency and their unit's proficiency in each skill set. Finally, the live exercise served as an indicator of the participants' practical application of the skills in the real world.

We used the same knowledge tests that had been used in Experiment 3 with Weapons and Field Training Battalion. These tests consisted of eighteen multiple choice questions each. The questions on the two tests were paired. In this way, the tests were different, but each test had the same number of questions in each domain. For example, if Test 1 had a question about unblocked ambush, Test 2 had a similar question. Data from Weapons and Field

Training Battalion was used to ensure the tests were equally difficult. Participants took one of the tests before training and the other test after training. To further avoid testing bias, half the participants in each group took Test 1 first and Test 2 second and vice versa for the other half. The tests are included in Appendices P and Q

The survey portion of the experiment also used the same paperwork that was devised for Experiments 2 and 3. The three-page initial demographic survey, included as Appendix M, featured several questions about the individual, such as age, rank, time in service, computer usage, and convoy experience. Another set of questions intended to determine the participants' attitudes toward personal computer-based simulation training. The next set of questions determined the participants' perception of tactical skill in the trained skill sets. As an addition to the Experiment 3 survey, a follow-on set of questions determined the participants' perception of their unit's tactical skill (that is, a person may believe he does not understand how to react to an IED because he is novice, but that the platoon as a whole is trained in that skill). Responses to all attitude and training proficiency questions were recorded on a five-point Likert scale. After the training, participants completed a survey with the same simulation attitude, individual training proficiency, and unit training proficiency questions that were on the demographic questionnaire. They also had a page to record subjective comments as answers to several open-ended questions about what they liked and did not like about the training. The questionnaires were the same for simulation groups and for the control group, with the following exceptions. On the post-training questionnaire, the control group did not have computer attitude questions. Also, on the post-training questionnaire, the simulation groups answered a set of Likert scale response questions addressing their simulation experience. The post-training survey for the simulation groups is included as Appendix N, and the post-training survey for the control group is included as Appendix O.

The live exercise was a portion of a regularly conducted training package designed for reserve infantry battalions training at Camp Pendleton. This battalion was the sixth to complete such training. The training package consisted of an urban patrolling component and a vehicle convoy component. The vehicle convoy portion consisted of two days of repetitively conducting a short three-mile course and three days of operating on a longer twenty-mile course. The short course included the following evaluated skill sets: establishment of a snap vehicle checkpoint (VCP), reaction to an IED, and reaction to IED-triggered ambush. Because any of the events could trigger a vehicle or personnel casualty, the exercise adequately served as a mechanism for observing the trained skills in practice. A cadre of three Marines graded the short convoy course. All of the training cadre had graded the same course for other companies in the battalion. Evaluators graded each vehicle on the course using a three-point rating of untrained (U), trained (T), and mastery (M). The evaluator grading system was developed by adding the three-point grading scale to the debrief form already in use for the exercise, and the resulting evaluation form is included as Appendix S. All evaluated portions of the course were positioned in terrain so that evaluators could observe the unit's activity from high overwatch positions or from within the convoy itself.

The simulation training encompassed the two separate treatments of full mission and part-task training. *VBS 2*™ offers several terrain databases, and we used two separate databases to give the Marines variety in their training experience. We used the Twentynine Palms database for initial training including the interface familiarization exercise. The Twentynine Palms database is a virtual replication of the Marine Corps' training areas at the Marine Corps Air Ground Combat Center in Twentynine Palms, California. This terrain features open desert with mountains dividing the area into distinct corridors. The terrain covers a large space more than 60 kilometers east to west and more than 40 kilometers north to south. For the more difficult training exercises, we used the Sahrani database. Sahrani is an imaginary island developed for gamers that provides a Mediterranean feel. The terrain is hilly and wooded in many places. Rural settlements dot the landscape. The terrain area is much smaller, featuring only about 15 kilometers at its widest point from east to west; the whole database covers only 400 square kilometers.

Both simulation groups started training by completing the informed consent paperwork, demographic survey, and initial knowledge test. They then completed an hour of interface familiarity training based on the work from Experiment 1. Afterward, they completed a short exercise called “Training Wheels” simply to familiarize them with the idea of working together in a vehicle convoy, using platoon communications, and coordinating movement and fires.

After the initial paperwork and training, MAP 1 participated in the full mission training. Throughout the four days, MAP 1 completed five convoy scenarios in the Twentynine Palms database and two scenarios in the Sahrani database. Each of the scenarios involved all four skill sets in question. In general, MAP 2 concentrated on casualty evacuation the first day, vehicle evacuation the second day, reaction to ambush the third day, and reaction to IED the final day. The final exercises did not involve true isolation of the skill sets; for example, participants in a reaction to ambush scenario might have to evacuate a casualty at some point because of the course of events. Both platoons executed the same final full mission exercise in Sahrani terrain at the end of the training evolution. Table 7 shows the details of the training plan for both platoons.

Preparatory training for all	
Familiarity	Interface training package with practice exercise
Training Wheels	Convoy movement practice
Full mission training scenarios		
Level 1	Noble Pass	Inert IED, Ambush 2x fire team (FT), Squad with inert IED and single vehicle and personnel casualty
Level 2	Gays Pass	1x FT, 1x Squad, 1x FT with daisy chain IED and vehicle and personnel casualty, civilian farm
Level 3	Rainbow Canyon	2x trucks, 1x Squad with IED, civilian farm, 1x FT with daisy chained IED and vehicle and personnel casualty, 1x FT, civilians
Level 4	Sahrani Iguana	1x RPG dismount with live IED, 2x RPG dismounts, 1x FT, 1x Squad with daisy chained IED, 1x RPG dismount, intermittent traffic and civilian activity

Part-task training scenarios

Task	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Casualty	Trng Wheel Casualty	Noble Pass Casualty	Gays Pass Casualty 2x casualty	Cayo Casualty 2 sep cas FT / RPG	Hunapu Cas Pers 3x casualty FT + Truck	Cresta Free Play 1 Truck Place cas
Vehicle	Trng Wheel Casualty	Noble Pass Casualty	Rainbow Casualty 2x casualty	Hunapu Cas Veh 2 sep cas RPG/Truck	Cresta Casualty 2x casualty FT	Hunapu Free Play 1 Truck Place cas
Ambush	Trng Wheel Ambush	Noble Pass Ambush 1x FT targ't	Gays Pass Ambush 1x FT inert	Hunapu Ambush 2x FT Live	Cayo Ambush Squad+FT	Cresta Free Play 2x Truck
IED	Trng Wheel Casualty	Noble Pass IED Undefended	Rainbow IED 1x IED RPG Team	Cayo IED 2 sep IED RPG each	Cresta IED IED+Chain RPG/2x FT	Hunapu Free Play 2x Truck Place IED

Evaluation exercise for all	
Sahrani Ixel	1x FT, 1x FT with daisy chained IED and personnel casualty, 2x trucks, 1x Squad with daisy chained IED and personnel casualty, 1x sniper, intermittent traffic and civilian activity

Table 7. Convoy training matrix for simulation groups

For both simulation training groups, the exercises increased in complexity. We varied this complexity in different dimensions. First, the exercises had varying degrees of assistance. All exercises included a map, and that map may have provided a location and description of the problem the unit would react against, just a location of the problem, or no information about the problem at all. For early exercises, an overhead view of the exercise area was projected for the participants so they could see a macro-level view of their actions and the actions of others. Second, the exercises had varying levels of collateral activity. Initial exercises featured nothing other than the exercise problem itself. More difficult levels included civilians, cars and traffic, animals, and buildings and built up areas. Third, the problem difficulty increased within each skill set. More difficult scenarios involved reacting to multiple casualties instead of just one; recovering multiple vehicles instead of just one; reacting to chained IEDs, fake IEDs, and remotely detonated IEDs; and complex ambushes with integrated Rocket Propelled Grenade (RPG) gunners and potential crossfire situations. Enemy activity was more coordinated in advanced exercises, requiring convoys to deal with more than one problem at once (e.g., reacting to ambush while evacuating a casualty). Advanced exercises also incorporated some enemy indirect fire.

The control group participated in exercises that mirrored a combination of the part task and full mission groups' activities. To mirror the part-task activities, the platoon conducted immediate action drills with actual weapons and vehicles on the local parade deck. Like the part-task group, the control group concentrated on a single skill set per day. To mirror the full mission activities, the control group conducted sand table exercises that were similar to the full mission scenarios executed in simulation. The platoon commander used the full mission simulation materials to develop his sand table training.

C. RESULTS

The study involved three different measures of effectiveness: knowledge tests administered before and after training; surveys administered before and after training; and a live exercise conducted after the training. Only the surveys produced significant results. We will discuss the results from each of these evaluation mechanisms in turn.

1. Knowledge Tests

We graded the multiple choice tests that were taken before and after the training and recorded the answers in a spreadsheet to analyze differences in the two tests. We summarized each participant's performance with the number of correct answers produced on each test. We then looked at the simple difference between correct answers on the before test versus the after test. We used ANOVA to test whether there was a difference in the mean performance of each platoon; no significant difference resulted. We also conducted t-tests on the performance of each platoon separately to test the hypothesis that participants' academic knowledge of convoy operations improved after training. No platoon performed better on the knowledge test with significance.

We tested to see if the tests were truly equal in difficulty. First, we looked at participant performance on each 18-question test regardless of whether the participant took the test before or after training. On average, participants answered 9.87 questions correctly on Test 1 and 9.09 questions correctly on Test 2. Next we looked at participant performance when taking each test before training and then after training. On average, participants taking Test 1 before training answered 9.33 questions correctly, while participants taking Test 1 after training answered 9.86 questions correctly. Participants taking Test 2 before training answered an average of 9.18 questions correctly, while participants taking Test 2 after training answered an average of 9.10 questions correctly. For both ways of looking at the issue, there was no significant difference in the number of questions answered correctly, so no evidence suggested a significant difference between the two tests.

Finally, we investigated whether participants responded to the simulation attitude questions based on any specific biases from the demographic information. We used correlation and regression analysis to check each of the demographic categories and found no relation to the simulation attitude results. In summary, the practical application training, regardless of whether it was simulation, traditional, full mission, or part task, resulted in no change in academic performance on the convoy tests.

2. Surveys

a. Individual Attitude Toward Simulation

Participants who completed the simulation training took surveys before and after training in which they assessed their attitude toward simulation for training. They answered four questions using a five-point Likert scale grading system. We used this construct to analyze whether their attitude toward simulation changed as a result of the training by subtracting the difference between the before and after ratings for each skill. We analyzed these differences to determine whether the different types of simulation training produced different changes between the two platoons. One participant in the part-task platoon and one participant in the full mission platoon failed to complete the full week of training, so their initial surveys were not considered in this paired comparison. In total, responses were analyzed from forty-six participants.

First, we combined the four questions into a single composite score by averaging the answers to each question. We used a t-test to test the null hypothesis that the platoons did not differ in their change in attitude toward simulation. With an F-ratio of 7.2142 and a p-value of 0.0102, we found that the two platoons did differ with the full mission simulation trained platoon having a higher assessed attitude than the part-task simulation trained platoon. With this in mind, we examined more closely by performing the same analysis on each question individually. We found that the platoons only differed for two of the four questions. The full mission simulation trained platoon was higher for “Computer-based simulation is an effective training tool” and “I think a unit should use computer-based simulation in its tactical training." The platoons did not differ for "Today's planned training will improve my ability to conduct convoy operations" and the mirror question for the unit's ability. Table 8 lists the data for this analysis.

#	QUESTION	F-RATIO	P(> F)
	COMPOSITE – Attitude toward simulation	7.2142	0.0102
1	Computer-based simulation is an effective training tool.	6.7368	0.0128
2	Today's planned training will improve my ability to conduct convoy operations.	2.0873	0.1556
3	Today's planned training will improve my unit's ability to conduct convoy operations.	1.2564	0.2684
4	I think a unit should use computer-based simulation in its tactical training.	8.6139	0.0053

Table 8. Analysis of before and after responses to statements related to attitude toward personal computer-based training; yellow highlight indicates significant difference in attitude between MAP 1 and MAP 2

Next, we analyzed the questions by platoon, as shown in Table 9, to see how each platoon's attitude toward simulation changed as a result of the exercise. We calculated a difference between Likert scale marks for each question before and after training. We then used a t-test to investigate the null hypothesis that the platoon's attitude toward simulation did not change. For the full mission simulation trained platoon, we found no evidence to reject the null hypothesis. However, for the part-task simulation-trained platoon, attitudes toward simulation went down for all but "Today's planned training will improve my ability to conduct convoy operations."

	MAP 1		MAP 2	
Question	t Test	Prob>|t|	t Test	Prob>|t|
Composite	1.0675	0.2973	-2.9376	0.0076
1	1.4316	0.1663	-2.3976	0.0254
2	1.0000	0.3282	-1.0446	0.3075
3	-0.4393	0.6647	-2.1054	0.0469
4	1.2981	0.2077	-2.8680	0.0089

Table 9. Analysis of before and after responses to statements related to attitude toward personal computer-based training by platoon; red highlight indicates significant decreased attitude

In summary, the two simulation-trained platoons did differ in how their attitudes toward simulation changed as a result of the training. Specifically, they differed in their attitude toward simulation in general, while there was no difference in their attitude toward the training they received in this particular set of training sessions. There was no evidence that the simulation training changed the attitude of the full mission simulation trained platoon, but the part-task simulation trained platoon's attitude toward simulation got worse.

b. Individual Tactical Proficiency

Participants took surveys before and after training. On these surveys, they assessed their proficiency and the proficiency of their unit as a whole in a series of skills using a five-point Likert scale grading system. With this construct, we analyzed self-assessed proficiency by subtracting the difference between the before and after ratings for each skill. We then analyzed these differences to determine differences between platoons and perceived improvements in performance. One participant in the part-task platoon and one participant in the full mission platoon failed to complete the full week of training, so their initial surveys were not considered in this paired comparison. In total, responses were analyzed from seventy participants.

We combined some of the questions to create composite scores by skill group. We created one composite score encompassing all thirteen tactical skills as a group. Additionally, we created skill group composite scores including the combination of two questions addressing reaction to IED; two questions addressing reaction to ambush; three questions addressing weapons employment; and three questions addressing communications. Vehicle recovery and casualty evacuation were evaluated as stand-alone questions. We developed the composite scores for the skill groups by averaging the responses from the questions within the group.

We used ANOVA to determine whether the platoons differed in their perceived tactical proficiency before and after training, as shown in Table 10. We found that the platoons did differ based on the overall composite tactical score with an F-ratio of 7.95 and a p-value of 0.0008. Using pairwise t-test comparisons, we found that both MAP 1 and MAP 2 differed from MAP 3, but that they did not differ from each other. That is, both simulation-trained groups felt that their proficiency increased after training, but the traditionally trained group did not.

#	QUESTION	F RATIO	P(> F)
All	COMPOSITE INDIV – Tactical 1/2 p = 0.2347; **1/3 p = 0.0002; 2/3 p = 0.0098**	7.9489	0.0008
1-2	COMPOSITE INDIV – IED ½ p = 0.1386; **1/3 p = 0.0002; 2/3 p = 0.0149**	8.2399	0.0006
3-4	COMPOSITE INDIV – Ambush **1/2 p = 0.0243; 1/3 p = <0.0001; 2/3 p = 0.0057**	13.4983	<0.0001
6-8	COMPOSITE INDIV – Weapons	2.2811	0.1101
10-13	COMPOSITE INDIV – Communications	2.2122	0.1174

Table 10. Analysis of before and after responses to statements related to composite self-assessed individual proficiency by skill set; yellow highlight indicates overall significant difference within company, bold indicates between-platoon significant difference

Next, we looked at the skill group composite scores to see if this trend held across all skill sets. We used the same analysis methodology of starting with ANOVA to determine if there was a difference between platoons and then using pairwise t-tests to find which platoons differed. We found a difference between platoons for reaction to IED, reaction to ambush, vehicle recovery, and casualty evacuation. For reaction to IED, reaction to ambush, and casualty evacuation, the trend from the overall composite score was reflected; both simulation-trained groups felt that their proficiency increased after training, whereas the traditionally trained group did not. For vehicle recovery, only the full mission simulation trained group showed a significant improvement in perceived proficiency versus the traditionally trained group. For reaction to ambush, all three platoons were significantly different from each other; this was the only domain in which the two simulation-trained platoons assessed their proficiency differently. The full mission simulation trained platoon's self-assessed proficiency increased more than that of the part-task simulation trained platoon. For weapons employment and communications, there was no significant different between platoons in self-assessed tactical proficiency.

We examined more closely the tactical skill groups that showed significant differences by platoon to see if the individual scores reflected the trends of the parent composite grouping. Table 11 lists the results. For reaction to IED, this was the case. Both questions showed a significant difference between platoons, with the simulation-trained platoons having a higher perceived proficiency after training than the traditionally trained platoon. The reaction to ambush questions differed, however. Both questions showed a difference between platoons. For reaction to blocked ambush, the full mission simulation platoon had higher self-assessed proficiency than the part-task simulation trained platoon; the part-task simulation trained platoon did not differ from the traditionally trained platoon. Data analysis for the reaction to the unblocked ambush question followed the trend of the overall composite score, in which both simulation-trained platoons showed significance for higher self-assessed proficiency than the traditionally trained platoon, but did not differ from each other.

#	QUESTION	F RATIO	P(> F)
1	INDIV – React to an unexploded IED 1/2 p = 0.0947; **1/3 p = 0.0003; 2/3 p = 0.0437**	7.1301	0.0016
2	INDIV – React to an IED detonation 1/2 p = 0.3034; **1/3 p = 0.0010; 2/3 p = 0.0191**	6.2862	0.0031
3	INDIV – Take action against a blocked ambush **1/2 p = 0.0189; 1/3 p = <0.0001;** 2/3 p = 0.0910	8.6607	0.0005
4	INDIV – Take action against an unblocked ambush 1/2 p = 0.1573; **1/3 p = <0.0001; 2/3 p = 0.0017**	11.7701	<0.0001
5	INDIV – Cordon and 360 degree security	2.7234	0.0730
6	INDIV – Employ vehicle machine guns / weapons	2.3307	0.1051
7	INDIV – Mounted fire and maneuver	1.7102	0.1886
8	INDIV – Shift fires / cease fires	3.0269	0.0551
9	INDIV – Vehicle recovery / bump plan 1/2 p = 0.4481; **1/3 p = 0.0106;** 2/3 p = 0.0677	3.6691	0.0308
10	INDIV – Casualty evacuation 1/2 p = 0.1756; **1/3 p = 0.0366; 2/3 p = 0.0008**	6.2918	0.0031
11	INDIV – Communication with higher headquarters 1/2 p = 0.1469; **1/3 p = 0.0064;** 2/3 p = 0.1874	3.9630	0.0236
12	INDIV – Communication between vehicles in a convoy	0.2459	0.7827
13	INDIV – Communication between personnel in vehicle	0.7653	0.4692

Table 11. Analysis of before and after responses to statements related to self-assessed individual proficiency by individual question; yellow highlight indicates overall significant difference within company, bold indicates between-platoon significant difference

In summary, we saw a difference between platoons in tactical skills overall. In general, the simulation-trained platoons did not differ from each other, but both were higher than the traditionally trained platoon for self-assessed tactical proficiency improvement. Reaction to blocked ambush did not follow this trend, because the two simulation-trained platoons differed, with the full mission trained platoon having the higher self-assessed proficiency. Casualty evacuation did not follow this trend either, because only the full mission simulation-trained platoon showed significant increase versus the traditionally trained platoon. The weapons and employment and communications skill groups showed no difference between platoons.

Next, we looked at composite scores, and then each question individually, by platoon to determine whether there was a significant difference in self-assessed proficiency before and after training. We took the difference in Likert scaled responses from each question and conducted a t-test investigating the null hypothesis that there was no change in self-assessed proficiency. Across all three platoons and all questions, there was no decrease in self-assessed proficiency; participants did not feel they got worse regardless of platoon or skill domain. For the overall tactical composite score, both of the simulation-trained platoons increased in self-assessed proficiency, whereas analysis showed no change with the traditionally trained platoon. All platoons showed no difference for communication between vehicles in the convoy or communication between personnel in the vehicle. The full mission simulation trained platoon felt they had improved with significance for all other skill sets; the part-task simulation trained platoon agreed for all skills except cordon / 360 degree security and shift / cease fires. On the other hand, the traditionally trained platoon did not show any change in self-assessed proficiency for any skill. That is, the Marines in the traditionally trained platoon assessed their individual proficiency for all analyzed skills the same regardless of whether they had had the traditional training or not. Table 12 summarizes this analysis.

	MAP 1		MAP 2		MAP 3	
Question	t Test	Prob>|t|	t Test	Prob>|t|	t Test	Prob>|t|
Composite	4.9092	<0.0001	3.3374	0.0030	-0.36678	0.7171
C IED	7.9530	<0.0001	3.2874	0.0034	0.1088	0.9143
C AMB	6.3471	<0.0001	3.3249	0.0031	-0.8614	0.3979
C WEA	2.8395	0.0095	1.8433	0.0788	0.2413	0.8115
C COM	2.2170	0.0373	0.2277	0.8220	-0.4845	0.6326
PROF 1	7.1895	<0.0001	2.5171	0.0196	0.0000	1.0000
PROF 2	5.3911	<0.0001	3.8724	0.0008	0.1819	0.8572
PROF 3	5.1627	<0.0001	2.0765	0.0497	-0.6174	0.5430
PROF 4	6.0055	<0.0001	3.2137	0.0040	-1.0000	0.3277
PROF 5	2.5981	0.0164	1.5554	0.1348	-0.5692	0.5748
PROF 6	3.0262	0.0062	3.2137	0.0040	0.9010	0.3769
PROF 7	2.1054	0.0469	2.4721	0.0216	0.0000	1.0000
PROF 8	2.4721	0.0216	-0.6171	0.5435	-0.3271	0.7466
PROF 9	3.4583	0.0022	2.7324	0.0122	0.2531	0.8024
PROF 10	2.5543	0.0181	4.7997	<0.0001	-0.5489	0.5884
PROF 11	4.7500	<0.0001	2.6470	0.0147	0.3852	0.7036
PROF 12	-0.1817	0.8574	-1.4168	0.1705	-1.2817	0.2127
PROF 13	0.7676	0.4509	-0.6802	0.5035	-0.8106	0.4259

Table 12. Analysis of before and after responses to statements related to self-assessed individual proficiency by platoon; yellow highlight indicates significant increased proficiency

c. Unit Tactical Proficiency

The before and after surveys featured the same tactical skill set for unit proficiency as for individual proficiency. Thus, participants used the same five-point Likert scale grading system discussed above, but they rated their unit's proficiency for each skill instead of their own. An example demonstrates the utility of this evaluation mechanism. A Marine may feel that he is quite proficient at reaction to ambush, but his platoon's proficiency does not match his own because of newly joined Marines, unit leadership, or some other reason. Because the survey construct matched the individual survey described above, we used the same analysis methodology.

We used the same mechanism of creating composite questions and breaking the questions down as necessary depending on significance found.

That is, we developed an overall composite tactical skill, composed of IED, ambush, vehicle recovery, casualty evacuation, weapons employment, and communications composite skills. We used ANOVA to test the null hypothesis that there was no difference by platoon in ratings for the overall unit tactical composite score. We found evidence to reject this hypothesis with an F-ratio of 9.5772 and a p-value of 0.0002. Pairwise t-tests by platoon indicated the same trend as in the individual composite tactical score; that is, the full mission and part-task simulation training platoons did not differ significantly from each other, but they both differed from the traditionally trained platoon. In all cases, the traditionally trained platoon's self-assessed unit proficiency increased less than that of the simulation-trained platoons, as shown in Table 13.

#	QUESTION	F RATIO	P(> F)
All	COMPOSITE UNIT – Tactical 1/2 p = 0.5399; **1/3 p = 0.0001; 2/3 p = 0.0012**	9.5772	0.0002
1-2	COMPOSITE UNIT – IED 1/2 p = 0.3117; **1/3 p = <0.0001; 2/3 p = 0.0004**	12.9869	<0.0001
3-4	COMPOSITE UNIT – Ambush 1/2 p = 0685; **1/3 p = <0.0001; 2/3 p = 0.0153**	9.9240	0.0002
6-8	COMPOSITE UNIT – Weapons 1/2 p = 0.6791; **1/3 p = 0.0053; 2/3 p = 0169**	5.1195	0.0093
10-13	COMPOSITE UNIT – Communications 1/2 p = 0.2732; **1/3 p = 0.0070;** 2/3 p = 0.1090	4.0401	0.0233

Table 13. Analysis of before and after responses to statements related to composite self-assessed unit proficiency by skill set; yellow highlight indicates overall significant difference within company, bold indicates between-platoon significant difference

As in the individual case, we investigated the composite skill groups within the overall tactical skill set to see if all skill groups followed the same trend. We found that the trend held for all composite skill groups, so we examined to the final level to determine whether the trend extended to the individual questions within each skill group. For IED, ambush, vehicle recovery, and casualty evacuation, the trend remained the same. However, the trend did not extend to individual questions for two of the tactical skill groups. Within the weapons employment skill group, the "Shift fires / cease fires" skill violated the trend. In this case, the full mission and part-task simulation-trained platoons differed from each other, but the part-task simulation-trained platoon did not differ from the traditionally trained platoon. Within the communications composite group, only the "Communications with higher headquarters" skill followed the trend. There was no significant difference between platoon for "Communication between vehicles in a convoy" and "Communication between personnel in a vehicle." This unit rating trend for the unit communications composite group mirrored the trend for the individual communications group. Table 14 shows these results.

#	QUESTION	F RATIO	P(> F)
1	UNIT – React to an unexploded IED 1/2 p = 0.1531; **1/3 p = <0.0001; 2/3 p = 0.0006**	14.1274	<0.0001
2	UNIT – React to an IED detonation 1/2 p =0.5686; **1/3 p = 0.0002; 2/3 p = 0.0009**	10.0209	0.0002
3	UNIT – Take action against a blocked ambush 1/2 p = 0.0502; **1/3 p = 0.0005;** 2/3 p = 0.0963	7.0846	0.0019
4	UNIT – Take action against an unblocked ambush 1/2 p = 0.1470; **1/3 p = <0.0001; 2/3 p = 0.0033**	11.1145	<0.0001
5	UNIT – Cordon and 360 degree security 1/2 p = 0.5859; **1/3 p = 0.0050; 2/3 p = 0.0202**	5.0354	0.0099
6	UNIT – Employ vehicle machine guns / weapons 1/2 p = 0.3144; **1/3 p = 0.0259; 2/3 p = 0.0012**	6.1877	0.0038
7	UNIT – Mounted fire and maneuver 1/2 p = 0.8513; **1/3 p = 0.0328; 2/3 p = 0.0203**	3.6778	0.0319
8	UNIT – Shift fires / cease fires **1/2 p = 0.0142; 1/3 p = 0.0033;** 2/3 p = 0.6681	5.2798	0.0080
9	UNIT – Vehicle recovery / bump plan 1/2 p = 0.9619; **1/3 p = 0.0250; 2/3 p = 0.0259**	3.6621	0.0323
10	UNIT – Casualty evacuation 1/2 p = 0.2584; **1/3 p = 0.0006; 2/3 p = <0.0001**	13.4421	<0.0001
11	UNIT – Communication with higher headquarters 1/2 p = 0.8775; **1/3 p = 0.0005; 2/3 p = 0.8775**	9.2914	0.0003
12	UNIT – Communication between vehicles in a convoy	1.6562	0.2004
13	UNIT – Communication between personnel in vehicle	1.4421	0.2454

Table 14. Analysis of before and after responses to statements related to self-assessed unit proficiency by individual question; yellow highlight indicates overall significant difference within company, bold indicates between-platoon significant difference

Thus, the unit tactical skill ratings showed similar trends to the individual skill ratings. There was a significant difference in overall composite score. The difference occurred between the simulation-trained platoons and the traditionally trained platoon but not between the two simulation-trained platoons. This trend extended through most of the composite skill groups and individual skills. Notable exceptions included weapons employment and communications. For communications, the trend in differences only extended to communication with higher headquarters but not to internal unit communications.

As in the individual case, we examined each question individually by platoon to determine whether there was a difference in self-assessed unit proficiency before and after training. We used the same methodology of conducting t-tests on the differences between the responses to test the null hypothesis that there was no change in self-assessed unit proficiency. Here, it became readily apparent that the results did not match the trends of the individual analysis; the overall tactical composite rating demonstrated this, as shown in Table 15. Overall, neither simulation-trained platoon changed in self-assessed unit proficiency. On the other hand, the traditionally trained platoon showed a decrease in self-assessed unit proficiency with an F ratio of -3.1907 and p-value of 0.0041. That is, the simulation-trained platoons felt that their unit's proficiency was the same regardless of the training whereas the traditionally trained platoon rated their unit's proficiency worse after training. For the full mission simulation trained platoon, self-assessed unit proficiency only increased for the IED and ambush skills; there was no change for all other skills. The part-task simulation-trained platoon showed an increase in self-assessed unit proficiency for one IED skill, employing vehicle machine guns, and casualty evacuation. They showed a decrease in self-assessed unit proficiency for shift fires / cease fires internal communications between vehicles and personnel. The part-task simulation-trained platoon showed no change for all other skills. The traditionally-trained platoon showed a decrease in self-assessed unit proficiency in all skills except reaction to blocked ambush and vehicle recovery.

	MAP 1		MAP 2		MAP 3	
Question	t Test	Prob>|t|	t Test	Prob>|t|	t Test	Prob>|t|
Composite	1.7711	0.0898	0.8889	0.3841	-3.19068	0.0041
C IED	4.4108	0.0004	2.2906	0.0350	-2.7562	0.0118
C AMB	4.4427	0.0004	0.9220	0.3695	-2.2879	0.0326
C WEA	1.2922	0.2146	0.8081	0.4309	-2.9250	0.0081
C COM	0.2469	0.8081	-1.2983	0.2126	-3.5963	0.0017
PRO 1	5.6073	<0.0001	1.6833	0.1106	-2.9444	0.0077
PRO 2	3.1650	0.0060	2.6992	0.0152	-2.4167	0.0248
PRO 3	4.1974	0.0007	0.5236	0.6073	-1.6408	0.1157
PRO 4	3.7712	0.0017	1.1662	0.2596	-2.8369	0.0099
PRO 5	1.4606	0.1635	0.3688	0.7168	-2.4167	0.0248
PRO 6	1.1669	0.2603	2.2628	0.0370	-2.3385	0.0293
PRO 7	1.0000	0.3322	1.4286	0.1724	-2.1130	0.0467
PRO 8	1.3054	0.2102	-2.4739	0.0242	-2.9784	0.0072
PRO 9	1.7678	0.0962	1.5674	0.1355	-1.5964	0.1253
PRO10	1.3765	0.1876	4.0752	0.0008	-3.5521	0.0019
PRO11	1.9262	0.0720	1.6915	0.1101	-3.2516	0.0038
PRO12	-0.8994	0.3818	-2.2039	0.0416	-3.5521	0.0019
PRO13	-0.7651	0.4554	-2.4043	0.0279	-2.9424	0.0078

Table 15. Analysis of before and after responses to statements related to self-assessed unit proficiency by platoon; yellow highlight indicates significant increased proficiency, red highlight indicates significant decreased proficiency

d. Simulation Group Qualitative Ratings

Participants in both simulation groups rated nine statements about the training on the survey taken after training. We designed these statements to gain insight into the experience of simulation training itself. We used one way ANOVA to test the null hypothesis that there was no difference between platoons on the responses to these statements. We failed to reject the null hypothesis. We analyzed the responses to determine whether any individual statements yielded surprising results. Since we found no difference between platoons, we conducted this analysis in the aggregate by combining the responses from both groups. In general, participants responded to all questions with average markings near the middle rating. The two statements that a satisfied participant would rate lower indeed showed lower responses than the other seven questions. In summary, analysis of the qualitative ratings showed no difference between platoons and produced no interesting information worthy of report. Figure 11 shows these results.

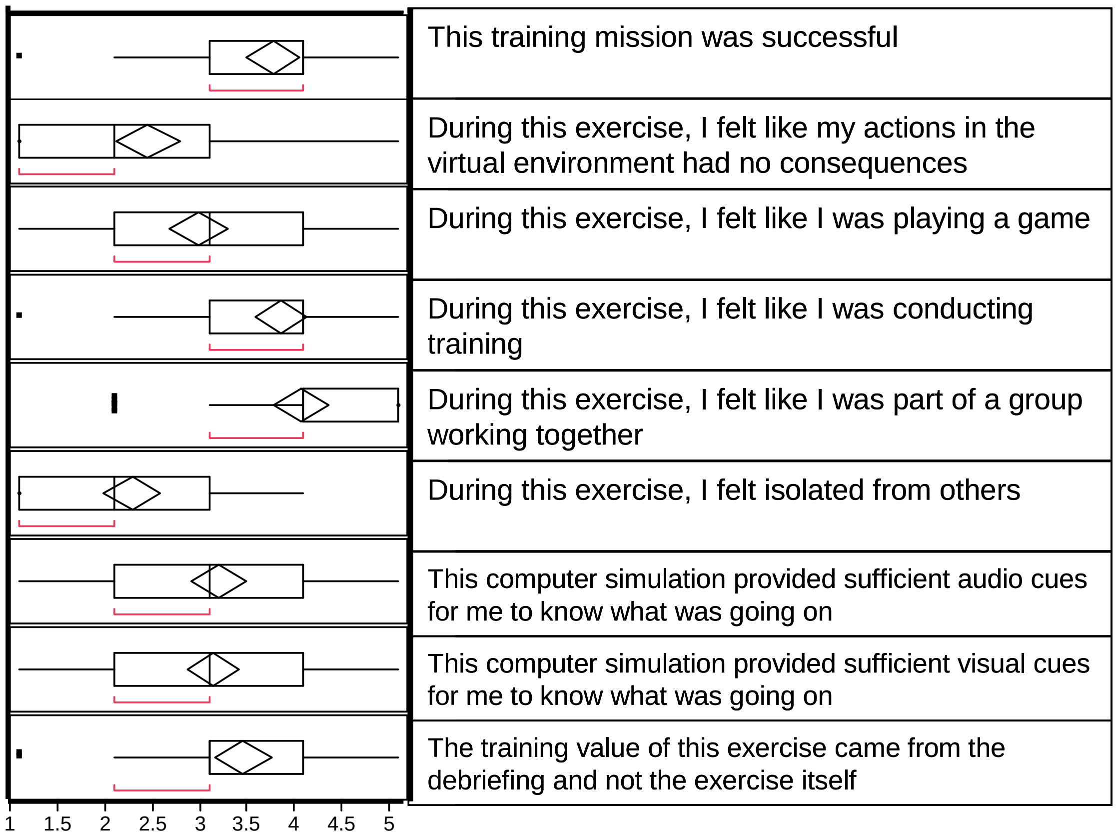

Figure 11. Analysis of qualitative ratings of simulation training experience

e. Comments

Participants had ample opportunity to provide qualitative feedback on the last page of the surveys taken after the training. Several questions served to guide the participants' comments. We asked participants to list the easiest and most difficult task for each of individual, vehicle crew, and unit performance. We asked what the participant liked least and most and then provided space for free comments. We examined this feedback by grouping the feedback comments into categories within each feedback question. For example, some participants responded that situational awareness was most difficult for them as an individual, so we grouped these responses together. While this informal methodology provided no means for statistical analysis, it did allow us to examine the multitude of purely qualitative comments for trends.

Also, we conducted an open interview session with each simulation training platoon at the end of the training. We used a standard set of questions, which included the following:

- What did you like about the training?
- What did you not like about the training?
- Did you like the progression of the scenarios?
- Would you rate the training with a thumb up or a thumb down?

When we combined the organized qualitative input from the survey forms with the group comments in the interview, we noticed several points worth mention. For the simulation-trained platoons, Marines commented on communications more than any other topic area, and the comments were both positive and negative. Throughout all of the simulation training, communications posed the most technical glitches, so this problem received ample critique. Most Marines had an opinion about how participants should communicate as a vehicle crew, but their opinions did not necessarily agree. Some liked using the voice communications as a crew because it was more like the real vehicle. Others would have preferred to use the computer communications with a headset like a vehicle intercom. Since the vehicle commander had to wear a headset to use the convoy communications channel, he could not hear voice communications as well as the radio communications, contributing to this issue. On the other hand, convoy communications received many positive comments. Many felt that the simulation exercise had helped their unit improve in the area of unit communications. They wanted the driver to be able to hear the convoy radio net like in a real HMMWV. In general, trainees liked the challenge and training experience of the convoy radio net, but did not like the vehicle crew communication or technical glitches imposed by JVTR.

Both simulation groups remarked about the challenges of situational awareness. Both groups felt that the simulation training helped their unit in this area, but the training also posed some artificial challenges. For example, audible feedback such as explosions and gun shots come from the computer speakers, so they provide no directional cues like in the real world. On the battlefield, reactions to explosions occur instinctually because a person can determine relative direction and distance, but a laptop computer provides inadequate cueing for this. Also, *VBS 2*™ does not provide a view out of the driver's window, so the driver cannot see on the left side of the vehicle. The vehicle commander's view is very limited on the right side of the vehicle. The result is that the vehicle commander and driver have much less visibility than in the real world and must depend on the gunner to know what can be seen from the vehicle's point of view.

Both simulation platoons spent much time in the interview sessions discussing the keyboard interface. In short, the majority of the participants sought a console game-type controller for the simulation instead of a keyboard interface. They felt that such a controller would be more intuitive and more familiar from other leisure gaming activities.

In general, simulation-trained participants liked the progression of the scenarios. The full mission training platoon felt that the progression of scenarios started and ended at appropriate levels. The part-task training platoon, on the other hand, felt as a group that the early scenarios were too easy. However, the convoy commander adamantly disagreed and pointed out that the easy scenarios were very useful to him to work out the bugs in his immediate drill execution before facing the complications of the more advanced scenarios. Both simulation platoons viewed the Twentynine Palms terrain as lower fidelity and useful for introductory training while the Sahrani terrain was considered higher fidelity and more useful for advanced scenarios. Figures 12 and 13 show scenes from the two terrain databases.

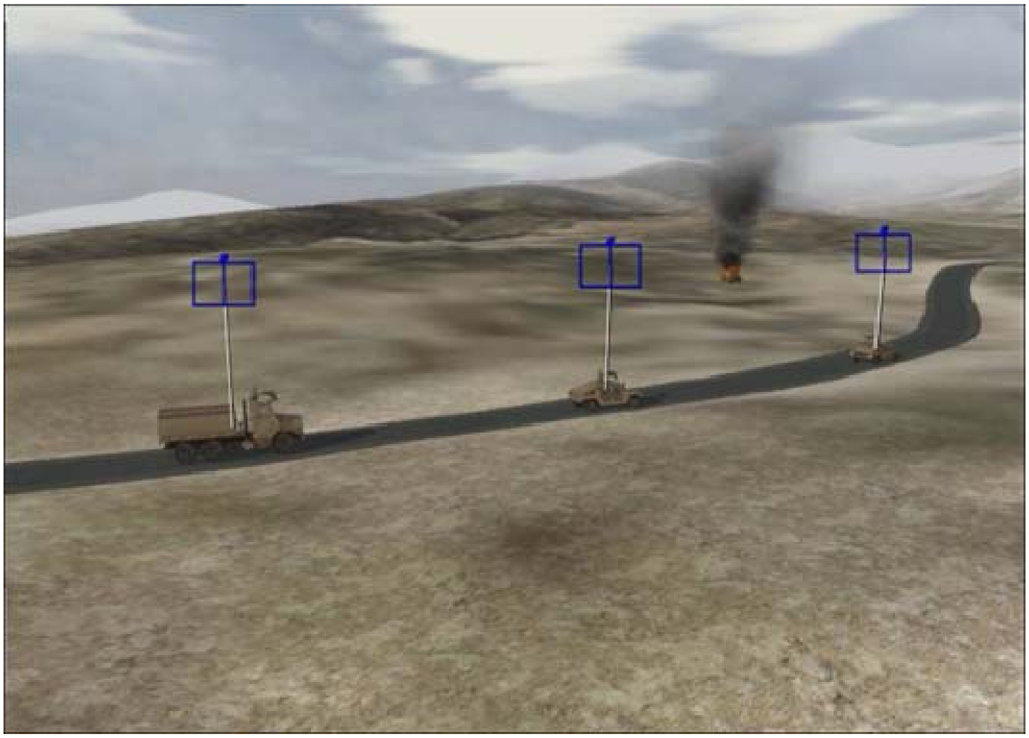

Figure 12. Twentynine Palms terrain in *VBS 2*™

Figure 13. Sahrani terrain in *VBS 2*™

Both simulation groups commented extensively on the AAR tool. Both groups believed the AAR tool was critical in providing a big picture view of what happened during the exercise. They liked the playback capability and liked seeing where others had been in the main action events of the training. Most participants felt like they had very little understanding of the enemy activity until seeing the AAR material, and they felt the AAR tool clarified the enemy situation considerably. Both groups felt the AAR tool was one of the most valuable aspects of *VBS 2*™ training.

Both simulation platoons reported that the training helped to develop the unit's immediate action drills. Immediate action drills, particularly reaction to ambush, were often listed as easy tasks for the simulation platoons. Both platoons often listed immediate action drills as one of the primary benefits of the simulation training.

The traditional training platoon's feedback tended to focus more on the conduct of immediate action drills than the feedback of the simulation platoons. The traditional training platoon rarely mentioned situation awareness or unit communication in their feedback. Most notable in the traditional training platoon's feedback was the lack of trend at all. Most Marines responded to the easiest and hardest questions with some aspect of an immediate action drill, but the responses were not particularly consistent in any way. The single point of consistency in the feedback was that the training took a long time for what was accomplished.

One common point among all three training groups was the desire to train on Mine Resistant Ambush Protected (MRAP) vehicles. At the time of the training, all MRAP vehicles were deployed to combat theater, and thus none were available for training. *VBS 2*™ does not contain MRAP vehicles as it is deployed on the DVTE suite. However, the Joint Training Counter-Improvised Explosive Device Operations Integration Center (JTCOIC) has used *VBS 2*™ as a platform for its activities and has developed an MRAP vehicle that can be loaded easily onto any *VBS 2*™ platform. Given the impending combat deployment, the Marines' desire to train with MRAP vehicles was understandable, and with available modification, *VBS 2*™ could have satisfied the need. Currently, the Marine Corps does not allow such local modification to DVTE suites, relying instead on centrally provided updates, so the MRAP from JTCOIC could not be used in this training.

Likewise, we conducted an open interview session with the platoon commanders who served as trainers for the three groups. The platoon commander who conducted the traditional training had used *VBS 2*™ in the past, so he had a perspective of the potential of the simulation. All three officers agreed that the strength of the simulation lay in the AAR tool's ability to aid the trainer in providing feedback to the training audience. Still, all three officers demonstrated skepticism about using personal computer-based training. They were not convinced that the training was worth the technical troubles of setting it up. Furthermore, the simulation platoon commanders felt that the view available in a personal computer was too restrictive for infantry training. All three officers agreed that training on a personal computer would pay off on deployment at sea, where no other training was possible and time was readily available to set up the system.

f. Live Exercise

The company participated in a six-day live field exercise with two primary training objectives: urban patrolling and mounted patrolling (Figure 14). Both exercises were based out of the Kilo 2 combat town area in Camp Pendleton. The mounted patrolling training package contained two segments: an initial short course and a longer, more comprehensive course. Marines ran the exercises at the platoon level, and vehicle constraints resulted in each platoon maneuvering with six vehicles. As previously discussed, the short convoy course met our needs as an evaluation mechanism for the simulation and traditional preparatory training. This course consisted of a roughly three-mile loop with three major events. During the exercise, Marines were exposed to an unexploded IED to gauge reaction expertise. They established and conducted a hasty vehicle checkpoint. The final station was initiated by a simulated IED detonation, and then a two-man oppositional force unit ambushed the convoy.

Figure 14. Marines operating vehicle check point in live convoy exercise

A cadre of six Marines controlled the entire operation, including the urban patrolling. A colonel served as the exercise controller and officer in charge and, for the most part, remained at a base station near the combat town. The controller team had essentially no military resources; they relied on personal vehicles or rides in the participating unit's vehicles for transportation and they relied on the participating unit's communications assets. Three Marines shared responsibility for evaluating the mounted patrolling courses, but all three Marines had other responsibilities as well. Typically, one or two Marines would monitor the short convoy course. For all short-course evolutions, a single evaluator rode in one of the participating platoon's vehicles. This unit evaluator dismounted whenever the unit stopped and monitored the action from whatever best vantage point could be gained on the ground. During movement, the unit evaluator simply rode in the vehicle. The controller cadre had the option to augment the unit evaluator with a second Marine using overwatch positions, or perches, as shown in Figure 15. For each of the three stations, the terrain provided a suitable perch to view the participating platoon's activity from an overhead view. Using the unit's Motorola radios, the controller cadre had sufficient communication to control the exercise and interact to provide meaningful insight into what was happening with the participating platoon on the ground.

Figure 15. Watching a convoy movement from an overwatch position

In previous exercises, the controller cadre used a standardized, custom-made form to record observations and provide debriefing feedback to the training unit. The form divided the exercise into its primary tasks and subtasks and provided lines to write information about each. In order to collect data, we modified the existing form by adding squares for each of ten vehicles. The controllers used a three-point scale to grade each vehicle on each of the tasks and subtasks. The scale included named markings of "untrained," "trained," and "mastery." Evaluators placed one of the three letters U, T, or M in the boxes to grade each vehicle for each subtask. If the exercise was evaluated by more than one Marine, the unit controller riding in one of the training unit's vehicles served as the primary controller and recorded all grades. The augmenting controller or controllers provided feedback to the primary, who incorporated the information into his overall grade.

Each of the platoons conducted two fully evaluated runs of the short convoy course. With virtually no exception, the evaluators rated the platoons as “trained” for each of the tasks and subtasks for all participating vehicle crews. The overwhelming number of “trained” ratings resulted in no significant difference by platoon, by vehicle crew, or by task category. Observational comments from controller cadre indicated agreement that there was no noticeable difference in platoon performance on the short convoy course.

g. Notes About Experiment Execution

(1) Controller Effects. For the simulation training platoons, we gradually and deliberately increased the involvement of the platoon commanders who were acting as trainers. We recognized the importance of the trainer as the link between the unit’s training objectives and the simulation exercise. We built all the scenarios used in the training before the training was conducted. With this done, trainers could involve themselves with the simulation in two ways: alter the scenario during the exercise run using the real-time editor, and run the after-action tool to display action from the exercise that best supported the learning points they wished to convey.

The concept of “building scenarios” can have different meanings for different trainers and training systems. In the context of this project, a “built scenario” included all players and gear in an initial starting position, all enemy in initial starting positions, and moderate amounts of objects that amplified the scene. Examples of amplifying objects included civilians along the street, civilian vehicles parked in driveways, and dirt pile cues near IED sites. Even a well-built scenario does not run by itself. The controller must monitor the enemy to ensure their actions are plausible, and advanced scenarios included traffic and moving civilians that had to be added and controlled through waypoints and other techniques. Thus, the real-time editor in *VBS 2*™ provided ample opportunity for the trainer or controller to affect the exercise to meet training objectives. As the controller, we did all this work without the assistance of the trainer. Throughout the course of the week, we gradually involved the trainer more until the trainer was doing most of the facilitation in the final exercises.

Likewise, the after-action tool records the exercise and allows a user to re-play the exercise while operating a camera that can view the exercise from any angle. Both the real-time editor and the after-action tool allow the user to view exercise activity from a two-dimensional map view with icon representations of players, or from a three-dimensional world view with avatar representations. Between the two views, the freedom of movement throughout the exercise environment, and the ability to re-play segments multiple times, the user has many different options available for using the after-action tool to make a learning point clear. It is conceivable that two different trainers could have completely different debriefs based on the same scenario by supporting different learning points with various camera angles and world views.

As we increased the involvement of the two platoon commanders, it became apparent that their styles of involvement differed. The full mission simulation training platoon commander used both the real-time editor and after-action tool aggressively to drive home the learning points he considered most important. At times, we had to reign in his real-time editor involvement in order to keep the exercise standardized enough to maintain the integrity of the experiment. The full mission platoon commander readily took charge of the after-action tool, manipulating the camera on his own to drive home his points about unit performance. On the other hand, the part-task simulation-training platoon commander took a much more reserved approach to both tools, relying more on the controller for support. The part-task platoon commander was noticeably more reluctant to assume control of the after-action tool, allowing the controller to choose the playback world view and camera position and then tailoring his comments based on what was projected. We did not anticipate this sort of difference between trainers, so we did not build a mechanism into the experiment to quantify it. Nevertheless, the difference was noticeable throughout the exercise week.

(2) Communications. We sought to run the experiment using *VBS 2*™ as Marines would use it straight out of the boxes of the DVTE suite with no other external support. With this in mind, we relied exclusively on the Joint Virtual Tactical Radio (JVTR) for communications. JVTR is a Single Channel Ground and Airborne Radio System (SINCGARS) radio simulator used to train Marines how to use the SINCGARS radio. This simulator can be used as a communications platform for other simulations in DVTE. In DVTE, one facilitates communication with *VBS 2*™ on a single computer by running JVTR simultaneously. This setup works well enough, but one must understand that the communications platform is an external add-on and not an internal component of *VBS 2*™. In this exercise, we only had a single radio net. The vehicle commanders used the net to communicate as a convoy unit. The convoy commander also used this net to communicate with the platoon commander acting as trainer. In this capacity, the trainer served as a higher headquarters to receive battlefield reporting and provide headquarters guidance. The controller also used this net to provide administrative instructions, as necessary, such as exercise start and end information.

We had many technical problems with communications, some of which interfered with the exercise execution. JVTR simulates a dual radio set with one radio going to one earpiece of the headset and the second radio sounding in the other earpiece. Since we were only using one net, we used only one radio. During the first two days, all of the JVTR radios would stop functioning at some point in the day. Through trial and error, we determined that we could fix the problem by programming both JVTR radios with the same net frequency. Once *VBS 2*™ was launched, we could not change the radios without stopping the simulation. This created a situation where it was usually better to have the participant continue the exercise without communications rather than shut the simulation down, fix the radio, and then try to get the participant back into the play of the exercise. We got around this problem by operating *VBS 2*™ in Windowed mode. Eventually, we ran all JVTR radios with the same frequency and the problem went away. However, the continuous communications troubles in the first two days caused a discernable amount of distress in the conduct of the exercise.

We also found that the JVTR radios would periodically shut down for the busiest users. Quite simply, a busy JVTR radio saturated the computer's buffer until the application locked up. We noticed that this problem occurred mostly with the convoy commander, so we solved the problem by providing communications for him on a separate computer. The convoy commanders readily adapted to the slight inconvenience of operating with two laptops. We drastically reduced JVTR problems in this way, and the few problems that did occur for the convoy commander could be remedied quickly.

(3) Technical SNAFUs (Situation Normal: All Fouled Up). We sought to use the scripting in *VBS 2*™ to facilitate the casualty evacuation and vehicle recovery training. A trigger allows scripting on the fly to accomplish various simple tasks. For both skills, we wanted to have explicit control of which individual or vehicle was a casualty. We used a fake IED to give the effect of an explosion. A fake IED produces an explosion but has no associated damaging effect. We then used a trigger to disable a certain vehicle or cause a certain casualty. Originally, we had these triggers pre-built in the scenario. We used the scripting reserved word "this" in the trigger. Unfortunately, this caused the effect to be applied to the whole unit instead of the single entity breaking the trigger bound. For example, we set a trigger to injure the driver of the vehicle that tripped the trigger, but all of the drivers in the convoy ended up getting injured at once. After a couple exercises, we fixed this problem. Since the part-task simulation-training platoon did casualty evacuation and vehicle recovery in the first two days, this problem affected them exclusively. While most participants

understood the technical problem and appreciated it as a humorous mistake, the part-task trained platoon got an unfair sampling of technical glitches up front because of this error.

In previous studies, we had noticed a computer glitch in which the vehicle crew representations got mixed up in the simulation. In a vehicle crew, a gunner would be unable to control his avatar and would continuously get thrown out of the vehicle despite repeated attempts to get back in. The vehicle's driver would get thrown out of the vehicle and be unable to get back in. The driver still would be able to drive the vehicle using keyboard controls. However, the driver would be left standing on the ground while the vehicle drove away, based on his keyboard input, such that the driver could not see where the vehicle was going. This glitch happened so rarely that we could not figure out how to fix it or replicate it for diagnosis. Marines often have the initiative to work through even the most inconvenient of problems, and a few vehicle crews managed to continue with the driver using the gunner's screen to control the vehicle and the gunner repeatedly getting back in the vehicle every few seconds. We eventually found that we could quite easily remedy this situation by changing either the driver's or the gunner's computer to map view and then pressing "Esc" to get back into the world view. However, through our initial lack of understanding of the problem—and their gallant initiative—a few Marines suffered undue frustration because of this problem.

(4) OPORD (Operational Order) Delivery. We intended to run the simulation training with minimal input to the unit's training implementation. We wanted to remain facilitators while the unit leadership remained trainers, and we sought to avoid blurring that line, if possible. We provided the basic scenarios and map materials in support of the training, but we did not provide operational orders that specified the background and mission of the exercise. We relied on the platoon commanders and their staff for this function. To keep the workload minimal, we provided an OPORD shell, included in Appendix R, to help their development efforts.

We noticed less input from the platoon staffs in the area of OPORD development and delivery than we had intended. We had tried to allow the platoon to use the blank slate of the scenario at hand to best suit unit needs, but instead ended up with a rather blank slate for the participants. The Marines relied heavily on the OPORD shell we provided, reading from it almost verbatim. Participants did not add in detail from the maps and terrain to tailor to the exercise at hand. Moreover, they did not add in their own Standing Operating Procedures (SOPs) and custom guidance. Thus, participants operated throughout the exercise based mostly on the provided map. Little planning affected the conduct of the exercise. However, the full mission simulation-training platoon put noticeably more thought and effort into OPORD preparation and delivery. While the simulation training we conducted certainly did not orient on mission planning skills, we could detect the differences in platoon preparation levels in exercise execution.

D. DISCUSSION

1. Hypotheses

At the most general level, this study allowed us to answer the two base questions quite simply. Preliminary training with *VBS 2*™ positively impacts performance in a platoon-level tactical scenario, so we reject the first null hypothesis. Specifically, the simulation training resulted in no difference in academic performance, significant difference in self-assessed proficiency, and no difference in live training performance. Additionally, there was not a difference between using a full mission approach versus a part-task approach to training when using *VBS 2*™ for platoon-level tactical training, so we fail to reject the second null hypothesis. This conclusion held across all three evaluation mechanisms.

We must interpret the results associated with the first hypothesis carefully. Essentially, Marines felt better about their tactical skill but failed to demonstrate improvement in a live setting. One must keep in mind the confounding factors of the human element in both the participation and evaluation of this exercise. With this in mind, one can use this study to conclude that the simulation training did no harm. That is, the simulation training was at least as good as the traditional training. However, a conclusion that these results prove that simulation training is better than traditional training would, in our opinion, risk extrapolating the information too far.

One must also remember that self-assessed proficiency did not differ significantly for all skill sets. Most notably, the training seemed to impact communications less than other skill sets, particularly communications at the vehicle crew level. At the individual level, the training did not impact self-assessed proficiency for weapons skills. It is also important to note that not all significant differences occurred as the result of improvement. For self-assessed unit proficiency, virtually all skills showed a significant difference, but the difference occurred because the control group's self-assessed proficiency decreased after training. This result may not suggest as much about the virtual training as it does about the traditional training. It may be that the traditional training revealed unit training deficiencies that never got corrected during the exercise.

Further, one must be aware of the limitations of the study. Between the two simulation groups, the potential for a trainer effect was demonstrated through the different techniques of using the real-time editor and after-action review tool. Technical glitches in both the communication and the simulation application itself interfered with the training experience. Finally, the evaluation of the live exercise was not robust enough to highlight fine differences in performance. While these limitations do not make the study results useless, they do impact the extent to which the results can be generalized.

2. Insights

We would like to differentiate this study from previous pilot studies discussed in this thesis. The previous pilot studies involved groups of people who were not, in any way, representative of the unit structure involved in the training. This study, on the other hand, involved an infantry company with a unit structure established specifically for motorized patrolling and convoy operations. While it is inherently obvious that this difference would change the training experience, it is worthy of mention. The simulation training worked far better with an intact leadership structure. Participants understood who was in charge, basic standard procedures, and individual personalities of the unit. These differences changed the face of the training completely. For the type of convoy training studied in these experiments, unit integrity is a key factor. Putting individuals through *VBS 2*™ training does not necessarily mean a unit or the individuals themselves are trained for the operation at hand. Rather, the training effect, if there is to be any at all, comes from training the unit as it will train live and as it will fight in combat.

This project also highlighted a difference in the training audience between the reserve infantry company and the active duty training cadre at Weapons and Field Training Battalion. We asked for a show of hands for both of the simulation platoons if the Marines were college students immediately prior to mobilization. Only a few Marines had not been enrolled full-time in college immediately prior to deployment to Camp Pendleton. We did not work to determine the courses these Marines had been taking or their academic goals and interests. Nevertheless, the mere fact of their almost-universal college enrollment separates these reservists from their active duty counterparts to some degree. The assumption that the findings from this study can be generalized to all Marines is confounded, to some extent, by this factor.

Some are quick to tout personal computer-based simulation as a training solution in order to appease the technophilic generation of young adults who fill the junior enlisted ranks of the Marine Corps. While these young Marines typically owned computers and used cell phones, they were not necessarily gamers. Moreover, the infantry is often a target audience for personal computer-based simulation, and the infantryman may be less technophilic than his counterparts in other job specialties. While both groups assessed themselves as more proficient in the selected tactical skills, neither group appreciated simulation training more after the exercise. Moreover, the verbal interview after the exercise resulted in mixed reactions to the training. Some Marines liked the training, some did not, and most had somewhat ambivalent views toward it. Readily assuming that a Marine will appreciate simulation training simply because he uses a personal data device and the World Wide Web is a fallacy. Marines will appreciate training that makes them better warfighters regardless of the level of technology involved.

Both platoon commanders and participants lauded the after-action review tool as critical to the positive *VBS 2*™ experience. Likewise, proactive facilitation of the exercise impacts training. Unit leadership can be involved in both the run-time execution of the exercise and the debriefing afterward. Further, *VBS 2*™ can accommodate different leadership styles effectively. However, using the real-time editor and after-action review tools effectively involves a learning curve. One can easily overcome this with a few exercise runs, but one cannot assume that unit leaders will get the most effect out of the simulation training based only on their tactical expertise. Leaders must get their hands dirty with the simulation operation.

As we increased the level of platoon commander involvement in the use of the real-time editor and after-action review tools, we noticed subtle differences in their use. Typically, the platoon commanders used the third-person world view during the conduct of the exercise. Administratively, we typically used the map view. During the debriefing, platoon commanders started the week with a preference for the third-person world view and started using the map view more as the week went on. The views differ in the level of detail provided to the eye.

The third-person world view makes the scene look realistic, but the map view shows important battle information, such as unit location and weapon orientation, explicitly. We found that most debriefing comments that were supported by the after-action review tool tended to involve one of three topics: firing unit's sight perspective, weapon orientation and shot direction, and entity position relative to other entities. The third-person world view is more suitable to see a situation from a gunner's point of view. The map view better demonstrates the direction of a shot; in fact, this information is explicitly displayed as a line on the map. Relative position is often more easily viewed at the macro level with the map view, but in close terrain with hills or buildings, the third-person world view is more useful. One could study Best Practices for the use of the different tools at length, but it is worthy of note here that the best use requires practice and experience. Just as a vehicle driver must learn the simulation interface to drive in the trainer as in the real world, the trainer must learn to use the real-time editor and after-action tools to train effectively.

Scenario testing is critical to a positive training experience. An exercise controller can easily test many aspects of the scenario by himself while constructing the scenario. *VBS 2*™ provides a very convenient way to test run the scenario from the editor. However, this practice does not test the scenario with group interaction. We missed the technical problem of all drivers becoming casualties as the result of one trigger because we were unable to test the scenario with a group. A single developer cannot make a finished training product; the developer must be able to test his exercise on a group of people. Fortunately, a controller on his toes can correct most mistakes in stride with the real-time editor, but a unit with critical dependence on a given scenario should ensure that it has been group tested before execution.

One must put much thought into exercise control. We designed all exercise components with a single controller in mind for the practical reasons of the experiment. We relied heavily on artificial intelligence driven enemy, civilians, and traffic. For the most part, we made all of these entities work effectively for the given training problem. With the single controller in mind, we put much effort into scripting these entities in scenarios beforehand. We found in practice that it was easier in most cases to create entities in stride using the real-time editor. This is not to say that a controller should start with a completely blank screen; the decision to add entities before exercise versus during the execution is a balancing act predicated on controller experience and ability. A more complex exercise could easily overwhelm a single controller. One must make consideration for multiple controllers and support for players acting as civilians and oppositional forces.

JVTR is a workable solution for exercise communications, but it may not be the best solution. JVTR, even operating at its best, brings the possibility of radio crashes due to buffer overload. At its worst, JVTR introduces communication problems that cannot be fixed during exercise execution. The problems are more difficult to diagnose than any *VBS 2*™ issues. By the very nature of communications, JVTR problems frustrate users and undermine the effectiveness of the simulation as a situational-awareness training tool. Certainly, a better solution would be an internal communications capability in *VBS 2*™ itself. In the absence of such software, a unit might be better advised to use external communications systems. This consideration is noteworthy when considering the out-of-the-box Best Practices for DVTE users.

3. Summary

Based on the results of this study, we conclude that preparatory training with *VBS 2*™ is at least as good as preparatory training by traditional methods such as sand table or garrison rehearsal. We conclude that the simulation can be used as a part-task trainer or a full mission training device. With these thoughts in mind, personal computer-based training is not the single answer to a training problem, but rather another capable and worthy tool for the trainer's toolbox. *VBS 2*™ does what it was designed to do; that is, it provides the trainer flexibility for resource constrained environments. Additionally, personal computer-based training complements traditional training well. When Marines tire of the sand table and parade deck, the computer provides an invitingly different perspective and experience. Thus, the simulation provides flexibility to the trainer. Considered by the dollar, this advantage may not seem worthwhile, but when the real world equipment is in transit or otherwise unavailable, the training areas are booked, and only a few days remain to get ready, personal computer-based training can be an attractive asset.

V. EXPERIMENT IN SUPPORT OF HYPOTHESIS 2

A. INTRODUCTION

In Experiment 4, we found that training with *VBS 2*™ produced a positive result for small unit tactical convoy training, although changes in performance were limited to increases in self-assessed proficiency. With knowledge that personal computer-based training was beneficial, we sought some insight into how this benefit can best be achieved. We based our work on careful contemplation of the trainer effect we had noticed in Experiment 4. That is, the full mission platoon commander engaged himself more fully in the conduct and debriefing of the simulation exercise than the part-task platoon commander did. We noticed this difference despite the distinct effort to involve both Marines. This led to the question of how the simulation training experience would differ if the direct involvement of the trainer were limited rather than encouraged.

We felt it important to investigate this effect because of the unique potential of the DVTE concept. Quite commonly, Marines searching for *VBS 2*™ will find it set up semi-permanently or permanently in local simulation centers. Our personal observation confirms this is true across major Marine Corps installations such as MCAGCC in Twentynine Palms, California and the I MEF Simulation Center in Camp Pendleton, California. Units have even pooled their DVTE resources to create simulation centers such as the 3rd Marine Regiment simulation center in Kaneohe Bay, Hawaii. In these simulation environments, Marine unit trainers implement the training exercise through the support of a contractor staff who facilitates the training. Using this construct, the Marine trainer provides the contractor with training objectives and specific desires such as terrain or equipment. The contractor then develops the appropriate scenario and controls the scenario execution for the unit.

However, DVTE is different. DVTE puts the personal computer-based simulation in the hands of the unit. With this construct, there is no contractor support staff. Instead, units send representatives, typically at the junior enlisted level, to a two-week course to learn how to operate DVTE as a suite and use each of the suite's simulation applications. The DVTE course runs on a regular basis at both Camp Lejeune and Camp Pendleton with additional courses at other installations such as Twentynine Palms. Thus, the Marine Corps makes DVTE training available to all units, and as such, a unit must send some representatives to DVTE training before their DVTE suite is fielded. These DVTE-trained Marines can then fill the role of the contractor support in the Marine Corps' various simulation centers. That is, given a set of training objectives and exercise specifications, the Marines can develop training scenarios and operate them in support of the unit's training goals.

Regardless of the perceived complexity of virtual environments, a serious game is nothing more than a training device, a tool of the trainer. With this in mind, a serious look at training effectiveness is more than an investigation of the tool; rather, it involves investigation of the trainer's use of the tool. The trainer's use of the tool involves his or her knowledge of the simulation as well as what he or she does with it. A simpler example illustrates this point. A hammer is a useful tool, and with it, one can build an entire building. However, without knowing how to use the hammer, one cannot build anything and may cause destruction and frustration in the process of trying. The effectiveness of a serious game involves a relationship between the simulation and the trainer.

In either of the DVTE usage situations described above, a third party potentially separates the trainer from direct interaction with the simulation exercise. We sought to investigate the potential of *VBS 2*™ if this separation was removed. We have discussed the concept of a Marine using *VBS 2*™ as an extension of his warfighting skills, and this idea was central to Experiment 4. In Experiment 5, we investigated the concept of a Marine using *VBS 2*™ as an extension of his training skills. We questioned whether the trainer's knowledge of the simulation could impact the simulation experience.

This chapter summarizes Experiment 5, in which we tested the following hypothesis:

- A trainer who has been trained in the operation of the simulation and is thereby able to control the simulation exercise will produce more effective training than a trainer who effects the simulation exercise through a third party.

B. METHOD

We turned to a school environment to test our hypothesis. The school environment provided a tested structure with an instructor cadre in place. Such a situation resulted in rigidly defined trainer roles that reduced the potential for a confounding trainer effect in the experiment. We selected the Enlisted Professional Military Education (EPME) program at Kaneohe Bay, Hawaii for our work. EPME Kaneohe Bay operates a seven-week professional training curriculum commonly known as the Sergeant's Course. This course focuses on the junior enlisted leader who fits the profile of the trainee at the center of our previous convoy training work, so the products we had developed in support of the first thesis hypothesis naturally fit in the EPME environment. The Sergeant's Course offers the student an overview of a broad array of topics spanning the entire Marine Corps from close order drill to equal opportunity. Tactical training only receives the brief overview perspective of any other topic area with most attention paid to mission planning and execution. Class sizes usually vary between twenty and thirty Marines. The instructional package follows a very structured and formalized standard managed by the headquarters at Training and Education Command (TECOM) in Quantico, Virginia.

EPME Kaneohe Bay suited our experiment well because the unit had not yet benefitted from its parent organization's dissemination of *VBS 2*™ training packages from the headquarters in Quantico. The school had a full DVTE suite on site but had not yet opened it for any purpose other than basic inventory.

EPME Kaneohe Bay was ready to start training with simulation, though. On the school's own initiative, the instructor cadre used white space in the course schedule to conduct a convoy simulation exercise at the Virtual Combat Convoy Trainer (VCCT). For a half or full day of each course, depending on schedule constraints, EPME students would run standard convoy exercises intended to familiarize them with the execution of a tactical plan. Since students hailed from any given job specialty in the Marine Corps, the school did not expect tactical prowess and was not particularly concerned with learning any given tactical skill. Rather, the trainer focused on the troop leading procedures, planning steps, and decision-making skills of a tactical operation and used the convoy exercise execution as a forum for the students to practice these concepts in an actual mission.

1. Participants

Participants in the experiment included three Sergeant's Course classes at EPME Hawaii. The experiment involved seventy-nine participants altogether with twenty-four participants in the first class, twenty-three participants in the second class, and thirty-two participants in the third class. All participants were Marine Corps Sergeants. We did not keep demographic statistics for the first class. For the second and third classes, the Sergeants had an average of 5.81 years in the Marine Corps (standard deviation 1.72 years). Participants averaged 25.33 years in age (standard deviation 3.11 years). Participants came from every facet of the Marine Corps with fifty different job specialties represented, including Marines from ground, aviation, and logistics elements. Eleven Marines participated in the study as trainers, although only five Marines saw the study from beginning to end due to personnel turnover. Trainers ranged in rank from Corporal to First Sergeant, averaged 28.50 years in age (standard deviation 4.81 years) and 8.98 years in service (standard deviation 4.44 years). Seven of the trainers had infantry backgrounds; the others came from supporting job specialties throughout the Marine Corps.

For the simulation-trained groups, we collected data about computer and simulation experience, convoy experience, and use of simulations versus sand tables in exercise planning and rehearsal. We used ANOVA or chi-squared tests as appropriate to test the null hypothesis that the groups did not differ any of the categories. We found no evidence to reject the null hypothesis for any demographic category.

2. Apparatus

VCCT provides a full mock-up of military vehicles surrounded by large screen projections to provide a fully immersive training experience. The VCCT at Kaneohe Bay contains six large bays, each with an individual replica of a HMMWV or MTVR. Trainees can participate in the exercise seated in the various seats of the vehicle, the gunner's station, or the floor area around the vehicle. In the case of the MTVR, participants can sit in the cargo area of the vehicle as well. Large screens around the bay, combined with a robust sound system, provide fully immersive visual and audio cues. Typical scenarios involve skill sets examined in our earlier work, including reaction to IED, reaction to ambush, casualty evacuation, and vehicle recovery. A contractor staff operates the simulation facility with most activity occurring in a control room, providing a standard exercise overview from an array of computer screens. The unit trainer occupies this room, providing exercise input and tracking execution details with the help of the contractor support.

As in previous experiments, we accomplished *VBS 2*™ training using the DVTE suite. In this case, we used the freshly unpacked equipment at EPME Hawaii. Specifically, the experiment used eighteen Dell Precision M6300 laptops that were networked using D-LINK DGS-2208 8 port switches. Peripheral equipment, including mice, cables, and switches, came from the standard DVTE package. The network configuration was the same as for all training exercises, although the instructor cadre dismantled the equipment and re-packed it between different segments of the training. We networked all computers together using switches, allowing all machines to participate together in the same environment. As shown in Figure 16, we used the forty-seat classroom for the simulation training with trainees occupying the first two rows of sixteen seats each.

Figure 16. EPME instructors training a Sergeant's Course class with *VBS 2*™ at Kaneohe Bay

Unlike previous experiments, we used the Combat Net Radio (CNR) in combination with the internal *VBS 2*™ communications. CNR is a proprietary software package designed to enable communications for a wide variety of simulations. Caltryx, the company who developed CNR, has cooperated with Bohemia Interactive to develop a CNR interface that operates with the *VBS 2*™ AAR tool. CNR has two components: CNR SIM serves as the radio communications, and CNR LOG serves as the recorder. CNR SIM allows users to select multiple nets, but CNR LOG records all radio traffic on the network regardless of net. For this reason, we only used CNR for convoy net communications. For communications within the vehicle, we used the internal *VBS 2*™ vehicle communications feature. This feature allows players to communicate depending on their vehicle association in the scenario.

3. Procedure

We designed our experiment to compare three treatments. In the first treatment, trainees received no simulation training at all. This control group served as a baseline. In the second treatment, students trained in the VCCT with the instructor cadre administering the exercise and conducting after action reviews through the third party support of the simulation facility contractors. In the third treatment, we trained the instructor cadre in the operation of *VBS 2*™. The instructors then used *VBS 2*™ on their own, with no contractor support, to conduct the training exercise. For convenience, we refer to these treatment groups as the control group, VCCT group, and *VBS 2*™ group, respectively. Because of the small class size, we followed three separate EPME classes, each class serving as an individual group. The experimental groups went in the order listed above; that is, the first class was the control group, the second was the VCCT group, and the final class was the *VBS 2*™ group.

We used two evaluation mechanisms to determine the effectiveness of the training for each group. First, we developed a survey mechanism based on our products for Experiments 2, 3, and 4. Participants filled out a demographic survey on which they rated their self-assessed skill proficiency and attitude toward simulation. They completed a post training survey with similar self-assessed skill ratings and simulation attitude ratings. They also answered some questions about their simulation training experience. The Experiment 5 surveys differed from the previous surveys in the addition of skills pertaining to troop leading procedures, mission planning, and decision making. We included the demographic survey as Appendix T and the post training survey as Appendix V. Second, we used a knowledge test. We used the knowledge tests developed for Experiments 3 and 4 as a basis for the Experiment 5 tests. We also used the same paired test design discussed in the previous experiments. That is, we used two different tests, each with twenty-four multiple choice questions. The questions were paired between tests. For example, if one test featured a question about reaction to IED, the other test featured a different question with similar intent. Like the surveys, the Experiment 5 tests differed from our previous versions because they contained questions related to troop leading procedures, mission planning, and decision making to reflect the goals of the EPME training. We included the two knowledge tests as Appendices Y and Z. Since the control group did no simulation training, they only took the knowledge tests as a baseline, answering all forty-eight test questions in one composite test. The VCCT and *VBS 2*™ groups took the survey and knowledge test before and after simulation training.

For the *VBS 2*™ group, we developed a training package for the EPME instructor cadre so that they could administer simulation training to the EPME class. We sought to provide a turn-key set of tools that the trainers could use at their discretion to effect the course's training objectives. We based the package on previously developed convoy scenario products. Specifically, we created a package that began with the Familiarity training exercise developed in Experiment 1. The convoy training involved a modified version of the full mission training package used in Experiment 4, starting with the Training Wheels scenario to get participants working together as a convoy team and then progressing to the Noble Pass and Rainbow Canyon scenarios in the Twentynine Palms terrain and the Ixel and Iguana scenarios in the Sahrani terrain. In addition to the scenarios themselves, the training package included the hot key cheat sheet developed in Experiments 1 and 2, all maps and the OPORD shell to support the scenarios, and the slide show we used to support the Familiarity training in all previous experiments. In general, we gave EPME our products from the Experiment 4 full mission training.

We conducted the instructor cadre training during a down period between Sergeant's Course classes over a three-day period (Figure 17). Ten instructors participated in the training, although ongoing commitments caused a few of the Marines to miss portions of the training. We started the first day of training by conducting the Familiarity exercise. We did not run the exercise exactly like previous experiments, because we spent extra time teaching the Marines how to run the Familiarity training by themselves. We followed the Familiarity training with an introduction to the communications systems and then had the Marine staff complete the Training Wheels scenario as a single convoy unit. Again, we focused on showing the Marines how to use the scenario themselves as the trainer. We spent the latter half of the first day teaching the Marines how to build a scenario by going through the full menu of *VBS 2*™ entities and explaining each. The entire training exercise was practical application with the Marine staff doing each trained task at his or her own laptop following our example shown by screen projection. On the second day, we introduced the Marines to the AAR tool, showing them how to switch views, find the action, and use the tool to meet training goals. For the remainder of the second day, we went through each of the four convoy scenarios in detail. Marines took turns acting as the controller while the rest of the staff participated in the exercise. We provided individual instruction to the Marine acting as controller throughout the exercise, focusing on the use of the real time editor to use triggers to achieve battlefield effects, provide the experience of civilians in the environment, and manipulate computer controlled enemy to achieve training goals. We projected the controller's screen on the Proxima so that the rest of the class could see what the controller did as we introduced new real time editor concepts. Thus, the second day of training was a combination of practical application, practice as a user, and individualized instruction oriented on giving Marines experience as an exercise controller. Throughout the training, we followed a list of notes that guided our instruction and provided the Marines an outline of the training as well as administrative information such as file locations and passwords. We included this notes sheet as Appendix V.

Figure 17. Instructor training with *VBS 2*™ at EPME Kaneohe Bay

We sought to investigate the effectiveness of the train-the-trainer package and the instructor cadre's impression of the simulation training. We used a pair of surveys. We administered the demographic survey after the train-the-trainer instruction. The demographic information was the same as all other surveys used in previous experiments. As in the other surveys oriented on simulation trainees, we asked the instructors for their attitude toward simulation training. We asked the Marines to rate how effective they expected *VBS 2*™ training to be for each of the tactical skills in the trainee surveys. We also asked the Marines to rate their proficiency in a variety of *VBS 2*™ controller skills. Finally, we asked for subjective comments about the train-the-trainer instruction. The post training survey asked for the same ratings of *VBS 2*™ effectiveness to train the various tactical skills. It also involved the same self-assessed proficiency for *VBS 2*™ controller skills. The post training survey asked questions about the simulation experience from the controller point of view. Finally, Marines rated which simulation trainer they would prefer for each of the tactical skills, choosing between VCCT and *VBS 2*™. The survey also provided the opportunity for subjective comments. We included the demographic survey as Appendix U and the post training survey as Appendix W. As in previous experiments, all survey products for Experiment 5 involved questions with five-point Likert scaled responses.

As in previous experiments, we used statistical group comparison techniques including the paired t-test for analysis. For all statistical tests, we used an alpha level of 0.05.

C. RESULTS

The study involved multiple measures of effectiveness. The knowledge tests administered before and after the virtual training provided insight into whether participants' factual knowledge of the skill areas changed as a result of training. Participant surveys administered before and after training measured changes in the individuals' self-assessed proficiency, providing a subjective look at changes in tactical performance as a result of the training. Comments on the participant surveys provided further subjective insight into the value of the training. Finally, instructor surveys administered before and after the training provided subjective information from the trainer's viewpoint. We will discuss the results of each of these evaluation mechanisms in turn and conclude with some notes about the study overall. In short, none of the evaluation mechanisms produced significant results in the data analysis. However, observation of the exercise in progress combined with analysis of the subjective comments provided noteworthy insights about the impact of the trainer on simulation training.

1. Knowledge Tests

This study involved three groups: the control group who received no virtual training; the VCCT group in which trainers implemented training through a third party; and the *VBS 2*™ group in which trainers implemented training directly by administering the simulation training themselves. The control group took a knowledge test with no virtual training at all in order to establish a baseline. The two treatment groups took knowledge tests before and after their virtual training. We graded all of the multiple choice tests and recorded the results in a spreadsheet for analysis, paying particular attention to the average number of questions missed overall.

We started by comparing the percentage of questions missed for each individual by treatment group. We used ANOVA to test whether there was a difference in performance on the final test by group, and we found no significant difference (F ratio of 0.2194, p-value of 0.8035). We also investigated whether the knowledge of either simulation trained group changed after training, using a t-test. For both groups, no significant difference in the number of correct answers resulted (for the VCCT group, t Ratio of 0.3184 and p-value of 0.7517; for the *VBS 2*™ group, t Ratio of -0.6644 and p-value of 0.5089).

The control group's knowledge test consisted of fifty multiple choice questions. We dropped two questions and split the test in half to make two tests of twenty-four questions each for the two treatment groups. The VCCT group took the two tests as planned with half taking Test A first and the other half taking Test B first. However, an administrative error resulted in the *VBS 2*™ group taking the fifty-question test instead of Test A. That is, the *VBS 2*™ group either took Test B or the entire fifty-question test (which included the twenty-four questions from Test B). We corrected this problem in the data analysis by only grading those questions that were on Test A. However, participants from the *VBS 2*™ group who took the fifty-question test before training saw the Test B questions twice.

2. Participant Surveys

We used the same techniques to analyze the participant self-assessed proficiency that we used in Experiment 4. Like the previous experiment, we analyzed individual attitude toward simulation, individual tactical proficiency, unit tactical proficiency, simulation group qualitative ratings, and comments. In general, responses from the VCCT group reflected a positive training experience and improved self-assessed proficiency while the *VBS 2*™ group's responses reflected much less deviation from the status quo. In total, we analyzed responses from twenty-three participants in the VCCT group and thirty-two participants in the *VBS 2*™ group.

a. Individual Attitude Toward Simulation

As in Experiment 4, we compared responses to five-point Likert scaled questions from surveys taken before and after the VCCT and *VBS 2*™ training. We started by creating a composite score of the four simulation attitude questions by averaging the answers. We used a t-test to test the null hypothesis that the platoons did not differ in their change in attitude toward simulation. With an F-ratio of 4.1614 and a p-value of 0.0465, we rejected the null hypothesis and concluded that the two treatments differed with the VCCT group having a higher assessed attitude than the *VBS 2*™ group. We scrutinized the individual questions to see if this difference was reflected across all questions. The trend held for all questions except "I think a unit should use computer-based simulation in its tactical training." For this item, the responses reflected no significant difference. Table 16 shows this analysis.

#	QUESTION	F-RATIO	P(> F)
	COMPOSITE – Attitude toward simulation	16.8145	0.0001
1	Computer-based simulation is an effective training tool.	4.1614	0.0465
2	Today's planned training will improve my ability to conduct convoy operations.	17.3745	0.0001
3	Today's planned training will improve my unit's ability to conduct convoy operations.	23.5620	<0.0001
4	I think a unit should use computer-based simulation in its tactical training.	3.1431	0.0822

Table 16. Analysis of before and after responses to statements related to attitude toward personal computer-based training; yellow highlight indicates significant difference in attitude between VCCT and *VBS 2*™ groups

Next, we analyzed the questions by group to see how each treatment group's attitude toward simulation changed as a result of the training (Table 17). After calculating the differences between before and after responses, we used a t-test to test the hypothesis that the group's attitude toward simulation did not change. For the VCCT group, we found evidence to reject the null hypothesis and determined that the group's cumulative attitude toward simulation improved. Individual scrutiny of each question reflected this trend with the exception of "Today's planned training will improve my ability to conduct convoy operations." On the other hand, while the *VBS 2*™ group's cumulative attitude toward simulation reflected no significant difference, the two questions specifically to "today's training" showed a significant decline in attitude.

	August (VCCT)		November (*VBS 2*)	
Question	t Test	Prob>|t|	t Test	Prob>|t|
C ATT	4.7956	<0.0001	-1.9461	0.0614
I ATT 1	3.8672	0.0008	0.0000	1.0000
I ATT 2	2.0057	0.0573	-4.0279	0.0004
I ATT 3	3.4254	0.0024	-3.93759	0.0005
I ATT 4	4.3761	0.0002	1.7255	0.0475

Table 17. Analysis of before and after responses to statements related to attitude toward personal computer-based training by virtual training group; yellow highlight indicates significant increased attitude, red highlight indicates significant decreased attitude

In summary, the attitudes of the two simulation groups differed. Both groups showed an increased inclination to believe that a unit should use simulation in its tactical training. However, when evaluating the impact of "today's training," the VCCT group believed more strongly after the training that the training helped at both individual and unit levels while the *VBS 2*™ group rated these questions lower. Additionally, the VCCT group's belief that simulation is an effective training tool increased after the training while the *VBS 2*™ group's opinion remained the same.

b. Individual Tactical Proficiency

As in Experiment 4, participants rated their proficiency in various skills before and after training, and we compared the responses to determine if the training positively or negatively impacted their opinion of their skills. As shown in Table 18, we started with composite scores and broke down the scores to the individual question level. Analysis began with ANOVA to test the null hypothesis that the changes in self-assessed proficiency did not differ between the two simulation groups. The overall composite score for all skills provided evidence to reject the null hypothesis and conclude that the groups differed. Specifically, the VCCT group's self-assessed proficiency increased more than that of the *VBS 2*™ group. Breaking the analysis down by category and then to the individual skill level demonstrated that this trend extended through all skills with the exception of "Shift fires / cease fires."

#	QUESTION	F RATIO	P(> F)
All	COMPOSITE INDIV – Tactical	25.2534	<0.0001
	COMPOSITE INDIV – IED	13.3330	0.0006
1	INDIV – React to an unexploded Improvised Explosive Device	14.7006	0.0003
2	INDIV – React to an Improvised Explosive Device detonation	11.2612	0.0015
	COMPOSITE INDIV – Ambush	7.4722	0.0085
3	INDIV – Take immediate action against a blocked ambush	8.9945	0.0041
4	INDIV – Take immediate action against an unblocked ambush	4.1814	0.0459
5	INDIV – Cordon and 360 degree security	8.8151	0.0045
	COMPOSITE INDIV – Weapons	10.4512	0.0022
6	INDIV – Employ vehicle machine guns / weapons	14.3834	0.0004
7	INDIV – Mounted fire and maneuver	8.4603	0.0053
8	INDIV – Shift fires / cease fires	3.5529	0.0651
9	INDIV – Vehicle recovery / bump plan	9.9786	0.0027
10	INDIV – Casualty evacuation	11.8349	0.0012
	COMPOSITE INDIV – Communications	34.6655	<0.0001
11	INDIV – Communication with higher headquarters	22.6119	<0.0001
12	INDIV – Communication between vehicles in a convoy	24.7351	<0.0001
13	INDIV – Communication between personnel in vehicle	26.2611	<0.0001
	COMPOSITE INDIV – Preparations	19.9135	<0.0001
14	INDIV – Execute the troop leading steps using BAMCIS	10.1581	0.0024
15	INDIV – Conduct mission analysis using METT-T	15.1204	0.0003
16	INDIV – Receive a 5 paragraph operational order	8.8146	0.0045
17	INDIV – Give a 5 paragraph operational order	16.0316	0.0002

Table 18. Analysis of before and after responses to statements related to self-assessed individual proficiency; yellow highlight indicates significant difference between simulation training groups with VCCT group having the higher ratings

Next, we calculated the difference between before and after self-assessed proficiency ratings for each individual and conducted t-tests by group to test the null hypothesis that each group's proficiency rating did not change (Table 19). For the VCCT group, we found evidence to reject the null hypothesis with self-assessed proficiency showing significant increase for all categories and individual skills. On the other hand, for the *VBS 2*™ group, only two categories showed significant difference: both the ambush and weapons skills demonstrated increase in self-assessed proficiency. Ratings showed no significant difference for other categories and skill sets.

	August (VCCT)		November (*VBS 2*)	
Question	t Test	Prob>|t|	t Test	Prob>|t|
I C ALL	5.6930	<0.0001	1.6593	0.1075
I C IED	4.6351	0.0001	1.4076	0.1695
I PRO 1	5.0091	<0.0001	1.2223	0.2311
I PRO 2	4.2040	0.0004	1.5323	0.1359
I C AMB	4.8465	<0.0001	3.2621	0.0028
I PRO 3	4.4770	0.0002	2.5593	0.0158
I PRO 4	4.5917	0.0001	3.3211	0.0024
I PRO 5	4.5344	0.0002	0.3485	0.7299
I C WEA	5.3531	<0.0001	2.6955	0.0114
I PRO 6	6.0694	<0.0001	1.0441	0.3048
I PRO 7	5.6000	<0.0001	2.8304	0.0082
I PRO 8	3.9056	0.0008	2.6833	0.0117
I PRO 9	4.8062	<0.0001	1.5626	0.1286
I PRO 10	4.6986	0.0001	1.0946	0.2824
I C COM	5.503471	<0.0001	-1.3374	0.1912
I PRO 11	5.3735	<0.0001	-1.4384	0.1607
I PRO 12	4.9698	<0.0001	-0.6485	0.5216
I PRO 13	5.0070	<0.0001	-0.9411	0.3542
I C PRE	5.0952	<0.0001	0.2314	0.8186
I PRO 14	3.2188	0.0040	-0.2543	0.8010
I PRO 15	3.7607	0.0011	-0.8915	0.3798
I PRO 16	3.8935	0.0008	1.2223	0.2311
I PRO 17	5.5235	<0.0001	0.7695	0.4476

Table 19. Analysis of before and after responses to statements related to self-assessed individual proficiency by simulation group; yellow highlight indicates significant increased proficiency

In summary, we observed a difference between changes in self-assessed proficiency. Regardless of skill domain, the VCCT group's self-assessed proficiency increased. However, the *VBS 2*™ group's proficiency ratings only changed for two skill groups. We noted no decrease in self-assessed proficiency ratings for either group or for any skill category.

c. Unit Tactical Proficiency

Just as participants rated individual skill sets before and after virtual training, they assessed unit proficiency for the skill sets as well. We used the same methodology to analyze the results, starting with ANOVA to test the null hypothesis that changes in self-assessed proficiency were the same by treatment group. As shown in Table 20, we found evidence to reject the null hypothesis in the case of the composite item and all subcategories and individual skills (F-ratio 25.4943, p-value less than 0.0001). Using a t-test to investigate the null hypothesis that each group did not experience a change in self-assessed proficiency, we found that the self-assessed proficiency ratings for all unit composite categories and individual skills increased for the VCCT group, as shown in Table 21. On the other hand, self-assessed proficiency for the *VBS 2*™ group decreased overall. Vehicle recovery, casualty evacuation, and communication accounted for this decrease; self-assessed proficiency ratings had no change for the other skill sets for the *VBS 2*™ group.

#	QUESTION	F RATIO	P(> F)
All	COMPOSITE UNIT – Tactical	27.4943	<0.0001
	COMPOSITE UNIT – IED	23.2832	<0.0001
1	UNIT – React to an unexploded Improvised Explosive Device	20.0585	<0.0001
2	UNIT – React to an Improvised Explosive Device detonation	25.7603	<0.0001
	COMPOSITE UNIT – Ambush	15.8090	0.0002
3	UNIT – Take immediate action against a blocked ambush	17.8025	0.0001
4	UNIT – Take immediate action against an unblocked ambush	13.0047	0.0007
5	UNIT – Cordon and 360 degree security	19.1706	<0.0001
	COMPOSITE UNIT – Weapons	22.9595	<0.0001
6	UNIT – Employ vehicle machine guns / weapons	18.8279	<0.0001
7	UNIT – Mounted fire and maneuver	21.2568	<0.0001
8	UNIT – Shift fires / cease fires	23.8085	<0.0001
9	UNIT – Vehicle recovery / bump plan	27.5881	<0.0001
10	UNIT – Casualty evacuation	21.4048	<0.0001
	COMPOSITE UNIT – Communications	32.0918	<0.0001
11	UNIT – Communication with higher headquarters	31.1784	<0.0001
12	UNIT – Communication between vehicles in a convoy	29.8752	<0.0001
13	UNIT – Communication between personnel in vehicle	30.2392	<0.0001

Table 20. Analysis of before and after responses to statements related to self-assessed unit proficiency by individual question; yellow highlight indicates significant difference between simulation training groups with VCCT group having the higher ratings

Question	August (VCCT) t Test	Prob>|t|	November (*VBS 2*) t Test	Prob>|t|
U C ALL	4.6770	0.0002	-2.3976	0.0229
U C IED	4.8492	0.0001	-1.3713	0.1804
U PRO 1	4.4853	0.0003	-1.3128	0.1992
U PRO 2	5.1514	<0.0001	-1.3926	0.1740
U C AMB	4.1309	0.0006	-0.9939	0.3282
U PRO 3	4.0105	0.0008	-1.3932	0.1738
U PRO 4	4.1576	0.0006	-0.5835	0.5639
U PRO 5	5.3785	<0.0001	-1.1791	0.2476
U C WEA	5.2778	<0.0001	-1.8082	0.0806
U PRO 6	5.2050	<0.0001	-1.4850	0.1480
U PRO 7	5.0000	<0.0001	-1.6473	0.1099
U PRO 8	4.6599	0.0002	-2.1818	0.0371
U PRO 9	4.9242	<0.0001	-2.5668	0.0155
U PRO10	4.3507	0.0003	-2.1356	0.0410
U C COM	4.3261	0.0004	-3.5634	0.0012
U PRO11	4.0559	0.0007	-3.8545	0.0006
U PRO12	4.3529	0.0003	-3.2303	0.0030
U PRO13	4.3333	0.0004	-3.2680	0.0027

Table 21. Analysis of before and after responses to statements related to self-assessed unit proficiency by simulation group; yellow highlight indicates significant increased proficiency, red highlight indicates significant decreased proficiency

d. Simulation Group Qualitative Ratings

As in Experiment 4, the participants rated statements about the simulation training experience on a five-point Likert scale. We used ANOVA to investigate the null hypothesis that the two simulation groups did not differ in their responses to these statements. For five of the statements, the VCCT group's responses were significantly higher than those of the *VBS 2*™ group. Table 22 highlights these responses.

#	QUESTION	F-RATIO	P(> F)
1	This training mission was successful	31.0227	<0.0001
2	During this exercise, I felt like my actions in the virtual environment had no consequences	1.3791	0.2458
3	During this exercise, I felt like I was playing a game	0.7526	0.3898
4	During this exercise, I felt like I was conducting training	10.4479	0.0022
5	During this exercise, I felt like I was part of a group working together	10.9551	0.0017
6	During this exercise, I felt isolated from others	2.5204	0.1187
7	This computer simulation provided sufficient audio cues for me to know what was going on	4.0546	0.0494
8	This computer simulation provided sufficient visual cues for me to know what was going on	1.7890	0.1871
9	The training value of this exercise came from the debriefing and not the exercise itself	20.3209	<0.0001

Table 22. Analysis of before and after responses to statements related to the overall simulation training experience; yellow highlight indicates significant difference between simulation training groups with VCCT group having the higher ratings

e. Comments

Participants provided free flowing subjective response to the training through open-ended questions on the last page of the survey. These questions asked what skills were easiest and most difficult for the individual, crew, and unit. Additionally, participants responded about how the exercise helped them and how it wasted their time. Finally, participants had the opportunity to provide any other comments they felt were important.

Given the statistically proven differences in attitude toward simulation and self-assessed proficiency between the simulation groups, the comments section demonstrated several common themes between the two groups. Communications, including crew communications, unit communications, and communications to higher headquarters, topped the list of concerns for both groups. Marines from both groups expressed concern that down time between scenarios wasted time. Both groups found situational awareness challenging, while they considered driving and shooting very easy skills in the simulation environment. Marines from both groups felt that the training helped to provide an overview of convoy operations, and they felt that more of the training was necessary and appropriate.

Comments differed in that many *VBS 2*™ participants provided negative overall comments such as “It [*VBS 2*™ virtual training] did not help the unit” and “patience for others learning controls” was a difficult individual skill. Other negative comments included “too little time to learn the program,” “no one knew what was going on,” and “get trained administrators.” The theme of too little training time was very common throughout the *VBS 2*™ training group with twelve participants annotating the comment somewhere in the survey. The trend of these comments did not criticize the simulation itself, but rather the administration of the exercise as exemplified by the following comment: “it [*VBS 2*™] could be a useful tool”. Participants directed some of the criticism toward themselves, such as “student discipline was poor.”

3. Instructor Surveys

The instructor cadre filled out surveys immediately after their *VBS 2*™ training and then again after conducting the *VBS 2*™ exercise with the Marine class. However, only five instructors filled out the post-exercise survey, and because of administrative problems with the surveys, we could only match two instructors’ pre- and post-exercise surveys. For this reason, we did not analyze most of the data from the surveys. However, it is worth noting that instructors rated their own proficiency for twelve administrator skills immediately after their training. All eleven instructors rated all skills with a three or higher on a five-point Likert scale.

One set of data, shown in Table 23, is worthy to note, even though it only reflects the input of the five instructors who completed the post-exercise survey. On one section of the post-exercise survey, the instructors rated whether they preferred VCCT or *VBS 2*™ for each of the tactical skills evaluated in the experiment. The survey used a five-point Likert scale to capture strength of preference with one indicating a strong preference for *VBS 2*^{TM}, three indicating no preference between the two, five indicating a strong preference for VCCT, and two and four indicating moderate preferences. We averaged the ratings for each individual skill so that averages below three indicated an overall preference for *VBS 2*^{TM} and averages higher than three indicated a preference for VCCT. Most of the ratings were within 0.5 of the "no preference" mark of three. However, a pattern emerged in the grouping of the averages. For tactical action skills such as weapon employment and reaction drills, instructors preferred VCCT. On the other hand, instructors preferred *VBS 2*^{TM} for communications and tactical planning skills. Skills that stood out with strong preferences included a preference for *VBS 2*^{TM} (average 2.0) for casualty evacuation and a preference for VCCT for mounted fire and maneuver (4.0).

#	QUESTION	AVERAGE	ST DEV
1	React to an unexploded Improved Explosive Device	3.5	1.4
2	React to an Improvised Explosive Device detonation	3.5	1.4
3	Take immediate action against a blocked ambush	3.5	1.4
4	Take immediate action against an unblocked ambush	3.5	1.4
5	Cordon and 360 degree security	2.4	1.7
6	Employ vehicle machine guns / weapons	3.5	1.5
7	Mounted fire and maneuver	4.0	0.9
8	Shift fires / cease fires	3.5	1.5
9	Vehicle recovery / bump plan	3.0	1.7
10	Casualty evacuation	2.0	1.1
11	Communication with higher headquarters	2.7	1.6
12	Communication between vehicles in convoy	2.7	1.6
13	Communication between personnel in vehicle	2.5	1.5
14	Execute the troop leading steps using BAMCIS	2.8	1.6
15	Conduct mission analysis using METT-T	2.8	1.6
16	Receive a 5 paragraph operational order	2.8	1.6
17	Give a 5 paragraph operational order	2.8	1.6

Table 23. Analysis of instructor preferences for VCCT or *VBS 2*^{TM}; numbers lower than three with yellow highlight indicate a preference for *VBS 2*^{TM} and numbers higher than 3.0 with green highlight indicate a preference for VCCT

Instructors also had the opportunity to provide subjective comments at the end of their training and at the end of the exercise. Comments at the end of the instructor training tended to be positive and optimistic, reflecting a confidence in the ability to run an exercise. The only negative trend was a desire for more training time with *VBS 2*™. Comments after the exercise execution reflected a positive attitude about the training potential of the simulation. However, instructors expressed concern about the technical aspects of the training with comments such as “not user friendly,” “too many moving parts,” and “time consuming setup.”

4. Notes About Experiment Execution

Some notes about the exercise execution are helpful in order to properly understand both the VCCT and *VBS 2*™ portions of the experiment. In this experiment, our role was primarily observational leaving little opportunity to change the course of the exercise. For this reason, the exercises did not always progress in the best interests of the study, but the deviations from the desired protocol proved instructive in themselves, providing insight into the impact of the trainer on exercise effectiveness.

For the VCCT exercise, the training cadre planned two runs of a convoy scenario with Marines changing roles for the second run. The staff had made some effort to organize the students prior to the event with a designated convoy commander and assistant convoy commander ready in the briefing room at the beginning of the exercise. The exercise proceeded with no difficulties from an administrative point of view. At the end of the exercise, the training cadre conducted a 20-minute after action review session using the VCCT playback capability administered by the contractor staff. The contractors spent a half hour re-setting the scenario while the Marines prepared for the second run. However, the contractors could not get the second run of the scenario to work properly, so the second run was aborted and the training ended about an hour earlier than anticipated.

Many shortfalls in the administration of the training hampered the *VBS 2*™ exercise. The instructor cadre had set up the computers early in the morning of the training day. The computers were properly networked and ready from a hardware standpoint, but they had just been booted. Only one instructor supported the training exercise. When the students were ready to train, communications had not been set up and there was no plan to do so. The scenario was not loaded. Without even a convoy commander identified, the student class was not organized in any way to conduct the training. The staff had planned for two hours of *VBS 2*™ training, which left a very short time to familiarize Marines with the interface, introduce a scenario, organize the students, conduct the training, and debrief the exercise. Quite simply, the time allotted was too short. Interface training was insufficient, Marines received no meaningful brief, the scenario was rushed, and the instructor conducted no after action review afterward. The instructor attempted two scenarios, but both were convoluted by gross situational awareness problems that were exacerbated by Marines yelling across the room in the absence of a communications system. The instructor typically focused on controlling enemy and neutral entities in the *VBS 2*™ environment, neglecting technical difficulties, higher headquarters responsibilities, and evaluation note taking and critique. In summary, the exercise was poorly planned, poorly supported, and poorly executed.

D. DISCUSSION

1. Hypothesis

Taking the statistical analysis of this experiment at face value, we find evidence to reject the null hypothesis of the experiment. We can conclude that a trainer who has been trained in the operation of the simulation, and is thereby able to control the simulation exercise, will produce training that is less effective to that produced by a trainer who implements the simulation exercise through a third party. Specifically, a trainer who implements the simulation exercise through a third party will produce better training than a trainer directly using the simulation tool. The improved self-assessment proficiency ratings of the VCCT group support this conclusion. Self-assessed proficiency increased for all tactical skill sets for the VCCT group but stayed the same or decreased for the *VBS 2*™ group.

However, this experiment had too many confounding variables to justify such a conclusion about the null hypothesis. Both exercises had flaws in their execution that confounded analysis. The poor planning and execution associated with the *VBS 2*™ exercise made the data collected virtually useless. Statistical analysis of instructor feedback was meaningless because of the small number of available surveys. In short, this experiment provided no means to say anything definitive about the null hypothesis.

However, the conduct of the *VBS 2*™ exercise provided insight into the hypothesis. The crux of the issue examined in this experiment was whether Marines received better training if the trainers implemented virtual training themselves or through a third party. Clearly, conducting training through a third party with VCCT provided a better training experience than instructor administered training through *VBS 2*™. It does not take a lot of statistical number juggling to understand why we saw such a result in this case. The *VBS 2*™ training was poorly planned and executed. Most likely, Marines would prefer a smoothly executed exercise more than a disorganized one no matter the forum, skill set, or venue. Thus, the question from this experiment that truly bears discussion is why the *VBS 2*™ training was poorly done.

2. Insights

a. Hammering Without Knowing Where the Nail Is

Virtual training, no matter what computer platform is used or who administers it, is nothing more than a tool to accomplish a training objective. In this regard, the virtual training platform is like any other tool: the user must know how it works, what to use it for, how to fix it when it breaks, what support it needs, etc. Most importantly, the user must know what he or she intends to accomplish with the tool. This statement seems so basic that it threatens to insult the reader's intelligence, but its violation caused problems in the execution of the *VBS 2*™ training in this experiment.

The senior enlisted leader of EPME Kaneohe Bay expressed the training goals for the virtual training very clearly. He sought to put the Marines in a tactical situation in which they would have to make a plan, execute the plan, and make decisions using teamwork and leadership in order to accomplish an objective. Unlike Experiment 4, the instructor staff did not specifically seek to improve the group's convoy skills, although it would have been a desirable side effect. Rather, the convoy scenario provided a tactical environment known well enough to the average Marine Sergeant that students could jump in and start making plans and decisions.

The execution of the *VBS 2*™ exercise reflected a loss of focus on the original objective. Instead, the instructors became focused on getting through the technical details of administering the exercise. Success got a very different definition, with instructors simply trying to get through all of the wickets to create a viable training environment for the Marines. Whether or not the Marines got the opportunity to make reasonable decisions got lost in the turmoil of making the event happen. Certainly, the focus on student learning was lost when instructors completely omitted the debrief, where decision consequences would logically be discussed and critiqued.

On the other hand, the VCCT training did not immediately demonstrate symptoms of this loss of focus problem. However, it is also difficult to conclude that the focus was clearly there. Rather, the instructors used a canned training program that the contractor staff ran routinely for many different units. The contractors knew how to run the scenario, had seen most of the variations on execution Marines would make, and knew how to run the playback tool prompting the instructor to debrief. The appearance of accomplishing the objective of facilitating a decision-making forum was more the result of contractor experience than instructor cadre intervention.

In summary, a trainer who forges ahead with his or her own training program must do so with clear objectives in mind. In the case of the *VBS 2*™ training, the trainers had the tool and knew how to use it. However, a carpenter who knows how to use a hammer but just beats on the wood accomplishes nothing. He must know where the nail is and hit it with each stroke. The same is true of trainer administered simulation exercises.

b. Practice Makes Perfect

When we trained the EPME Kaneohe Bay instructor staff to use *VBS 2*™, we spent three days on the training following a curriculum similar to the *VBS 2*™ portion of DVTE training administered by the contractors at the I MEF Simulation Center in Camp Pendleton. Such a curriculum is adequate to teach the basics of building a scenario, using the real-time editor to administer an execution run of the scenario, and using the after action review tool to facilitate debriefing. However, administering a *VBS 2*™ exercise to a group of novice users requires quite a bit of knowledge. The trainer must be able to apply that knowledge on his or her feet. There is no time to consult other people or documentation for an answer, and there is no liberty to experiment and figure out the answer. Once the exercise starts running, the administrator must know what he or she is doing and be on his or her toes at all times to keep the environment realistic for the training audience.

The three days of *VBS 2*™ training is clearly insufficient to provide this level of application knowledge for the average Marine trainer. It is not that more training is required, but rather that the trainer must have the opportunity to practice on a live training audience. All of the trainers in this experiment improved surprisingly quickly and came out of the experience ready to do a much better job the next time. Not only would such experience improve the next execution, but it would support much better planning as well. The trained but unpracticed *VBS 2*™ trainer is really not trained at all. Only practical experience can give the trainer the wherewithal to facilitate good training with a tool such as *VBS 2*™.

Nowhere did the issue of practice become more apparent than in time allocation. The two-hour period allotted for the *VBS 2*™ convoy exercise was far too short, even for seasoned administrators and users. The instructor cadre had not accounted for the time to load scenarios and set up the networks. They had no experience with their scenarios to gauge how long an exercise run might take. The resulting plan was a recipe for trouble from the beginning because every step of the process had to be rushed. With practice, instructors would not have attempted such a plan and would have made adjustments to provide a better chance for success.

c. Spreading the Trainer Too Thin

Three distinct roles are necessary to implement virtual training through a simulation platform like *VBS 2*™. First, someone must be the facilitator. In this role, the trainer has tasks such as making sure everyone gets networked into the scenario, causing civilian and enemy entities to act in accordance with the training plan, and remembering to record the scenario and bookmark it for easy review. Second, someone must be the technician. Almost certainly, some members of the training audience will experience technical difficulties. The problems may occur because of computer platform issues, networking problems, or software glitches. The training audience may induce problems through lack of experience, failed attempts to correct a minor problem, or accidental actions with unintended consequences. Whatever the source, the technician must handle technical problems so that “computer-isms” do not overshadow the training. Third, someone must be the planner/evaluator. The planner/evaluator determines the training objectives and designs or chooses the scenario to meet them. In the planner/evaluator role, the trainer acts as one or multiple higher headquarters personnel. The planner/evaluator must take notes about the exercise execution. Most importantly, the planner/evaluator must observe both the exercise itself as it unfolds in the virtual environment and the training audience as they work through the execution. This observation includes close scrutiny of the primary communications nets. For the scope of exercises covered in this thesis, a single trainer can fulfill all three of these roles capably as long as he or she maintains adequate control over the training audience. More likely, a training staff of two or more Marines should administer the exercise, and the roles can be divided between available personnel. Whether different people split the roles or a single individual performs them alone, all three roles must be properly handled for an exercise to produce successful training.

In the case of the VCCT training administered through a third party, the trainer is absolved of facilitator and technician duties. While the contractor handles these two roles, the trainer is free to focus on planner/evaluator tasks. The cost to the trainer is that direct facilitation is no longer possible and adjustments must be described to and interpreted by a third party.

The division of labor problem became painfully obvious in the execution of the *VBS 2*™ training. The trainer focused on the facilitator role to the exclusion of both the technician and planner/evaluator roles. We can explain this very simply. The facilitator role is fun. Never does an individual have such power as when facilitating a virtual exercise. The facilitator is right in the thick of the action making things happen every moment of the exercise. Once one learns the interface, it is easy to create complex problems for the training audience, and the effect is immediate and satisfying. Such a role appeals to the aggressive, controlling mindset of the typical Marine leader. Keeping notes about vehicle dispersion or figuring out why someone’s mouse is not working simply fall to the wayside when artillery is a finger click away and the enemy RPG team can be hidden just a little bit better. Nevertheless, no matter the appeal of any particular role, all three roles must receive equal emphasis or chaos will eventually begin to take over.

Thus, the number of trainers who implement *VBS 2*™ training is important. Curiously, in the VCCT exercise where contractors capably filled the facilitator and technician roles, the EPME instructor staff maintained at least two, and usually three, instructors to implement the training. On the other hand, when all of the demands of virtual training implementation rested on the instructor staff alone for the *VBS 2*™ training, the instructor staff allocated only one trainer to the exercise. For a novice staff, this personnel level is insufficient. At a minimum, one person needs to be tied to the control station computer while someone else is available to move about the training floor to help the training audience.

3. Summary

We do not believe that Experiment 5, when viewed in total, supports any determination about the null hypothesis. Unfortunately, the execution of the *VBS 2*™ exercise was too flawed to properly investigate the effects of direct trainer facilitation of a virtual training exercise. However, the flaws in the execution themselves illustrated the challenges of the trainer staff simultaneously filling the facilitator, technician, and planner/evaluator roles of a virtual training exercise. Experiment 5 demonstrated the importance of objective-oriented training, practice, and time and support personnel allocation on virtual training directly administered by the trainer. Future work could shed light on the potential of training in which these challenges are overcome. However, training administered through a third party circumvents these problems to a great extent, thereby reducing the risk of a poorly executed training event.

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VI. RECOMMENDATIONS AND CONCLUSIONS

A. CONCLUSIONS

Based on the results of Experiment 4, we conclude that serious games such as *VBS 2*™ are valid training tools for small unit tactics. Serious games do not necessarily produce better results than traditional training methods, but they perform at least as well. Serious games show an edge over traditional training methods in user satisfaction, possibly because they satisfy the technical whims of today's youth. From our observations, serious games are not a single answer to training needs, but rather a training multiplier to use with other training methods such as the sand table or tactical decision game. Serious games are a viable tool for the trainer's toolbox and are well worth the time, money, and effort to develop as core assets to a unit's or school's tactical training curriculum.

Serious games come with a price, however. The trainer must understand how to use the serious games as an extension of his or her training skills. Experiment 5 provided insight into a representative situation that demonstrated that a trainer's use of serious games is a learned and practiced skill rather than a natural and intuitive technique. The trainer must be able to clearly articulate training objectives. Then, the trainer must understand the capabilities and limitations of the serious game well enough to translate the training objectives into an implementable serious game exercise. For the serious game training to be successful, some combination of people must fill the roles of facilitator, technician, and planner/evaluator. The trainer must fill the last role and is better served knowing as much as possible about the first two. We did not find evidence to support the notion that the trainer's involvement in the facilitator role can improve the training experience, but we think this idea deserves further investigation. However, we did find evidence to support the conclusion that the trainer cannot focus on the facilitator role to the exclusion of the other roles; such a practice leads to a chaotic evolution.

We conclude, then, that the technical aspects of serious games are no longer the primary issue in providing innovative and effective small unit tactical training for Marines and soldiers. The driving issue at hand is developing the skill and experience of the trainer to use serious games effectively. We conclude that the training establishment must think out such a program carefully, plan it, support it, monitor it, and supervise it. A program that simply makes the training tool available to the trainer without actively changing the way a trainer develops his or her training program risks wasting the potential of the tool, wasting the time of the training audience, and wasting the valuable support dollars that brought serious games into the limelight.

A training transfer study seeks to determine whether a given training device makes an individual more effective or proficient in a certain task or mission. Tradition implies that this analysis should focus on the trainee. Throughout the course of this thesis adventure, we did just that with *VBS 2*™; that is, we demonstrated an improvement in self-assessed proficiency within a given skill set. More broadly, we determined that serious games are as effective, but not necessarily more so, than other training methods. If serious games are as good but no better than anything else, then the question boils down to what is better for the trainer. We conclude that it is time for the era of the trainee focused training transfer study to close for serious games. The focus of training transfer study in the serious game domain needs to turn to the trainer. Such a study should determine whether the serious game makes the trainer more effective in his or her mission. If the trainer cannot achieve training objectives more efficiently, serious games do not offer enough game to make them worth the time, money and hype. We firmly believe that serious games offer the trainer a whole new world of capability, but the trainer must be well educated in the employment of the tool to realize this potential.

B. OBSERVATIONS

This thesis provided a unique opportunity for comment on serious games. In this project a Marine Corps field grade officer learned to administer training with *VBS 2*™ through experience and self-instruction. All of our experiments were done with what we could learn from *VBS 2*™ as it came out of the DVTE boxes. Resources only included the manuals on the computers, the *VBS 2*™ website, and the on-line *VBS 2*™ support forum. We got a three-day summary view of the I MEF Simulation Center contractor-led DVTE training for comparison purposes after we had completed the bulk of this project. No outside training influenced our work. For this reason, the comments of an experienced trainer with the educational background provided by the NPS MOVES program who has implemented training using DVTE “out of the box” should have value to the tactical training community as well as simulation professionals.

1. Making *VBS 2*™ an Ubiquitous Trainer

At one time, in the early 1990s, Marine Corps officers approached commercial presentation software, such as Microsoft PowerPoint, with caution and trepidation. Officers did not know how to use the software. They were not used to seeing information presented with it. Thus, they looked at the software with reluctance and passed any duties associated with it to the lowest capable individual they could find. Now, most officers use such software quite easily, and modern audiences expect presentations developed with such software as a means of information exchange and consider these products the norm. This change occurred for two main reasons. First, Marines have learned how to use the software, at least at a basic level, through experience and observation. Second, Marines generally do not have to build presentations from scratch. Often, presenters provide information using presentation software formats that have been developed and refined over the years, and Marines simply have to cut, paste, and update to achieve their objectives. In this way, neither the learning curve nor the development curve is steep, so the software is much more palatable. The result is that in today's world, many would not know how to accomplish their jobs if the software suddenly disappeared.

VBS 2™ is at the same point that presentation software was two decades ago. Both the learning curve and the development curve are steep. Moreover, *VBS 2*™ is not the method with which people are used to having their training presented. The idea that personal computer-based training will one day reach the level of ubiquitousness enjoyed by presentation software is not far-fetched, however. The question, then, is how to shorten the learning and development curves.

A good way to shorten the learning curve is through schools. The learning curve stays long if no one understands what the product is and if nothing is done to teach it. The DVTE program provides a training package for unit representatives upon dissemination of the gear, but this program does not lend itself to ubiquitousness. It only temporarily provides someone who can turn on the machines. Without a program in place to continue training, this temporary fix will not live. Ubiquitousness occurs through an organized approach that systematically touches everyone in the Marine Corps at one point or another. Resident schools provide such an opportunity. Resident schools have a standardized hierarchy organized through TECOM. Students in resident schools have the time and motivation to focus, so instruction does not get lost in a series of competing unit demands. Finally, schools can provide students with the chance to experiment and ask questions. Not all Marines go to the appropriate resident school for their grade. However, if *VBS 2*™ and other simulations were taught in the schools for NCOs, SNCOs, company grade officers, and field grade officers, units would have a sprinkling of simulation interest to get personal computer-based training out of its infancy. However, the Marine Corps and other DoD services must approach this training in schools with discretion. Junior leaders do not need to focus on the key that makes the avatar move forward. Rather, they need to focus on how to use the simulation as an extension of their training capabilities. This includes the technical ability to develop, run, and debrief scenarios as well as the ability to integrate the simulation into the unit's training schedule to provide a complementary medium to enhance the achievement of unit objectives.

The armor community offers an example of this concept in practice. For both the Marine Corps and Army M1A1 tank communities, a Master Gunner serves as the expert for all matters related to tank gunnery. This enlisted tanker goes to an intense school at Fort Knox, Kentucky to learn about all aspects of making the tank put main gun and machinegun rounds on target. Part of this training includes instruction about the use of the Advanced Gunnery Training System (AGTS), the simulator to train the gunner and tank commander in crew level gunnery skills. Not only does the Master Gunner learn to use AGTS, but he learns to develop a company level gunnery training plan that includes AGTS as a core component of the annual training cycle. There is no reason that training with serious games cannot follow such a model, and we recommend scrutinizing this concept for potential ideas about incorporating *VBS 2*™ into training curricula.

The training establishment can shorten the development curve through an organized proliferation of user generated simulation products. Users should not be creating their training from scratch. If one unit puts together a solid simulation training package for a certain training objective, there is no reason someone else should do the same work over again. However, the creation of an environment in which users can pool their work spawns a variety of obstacles that must be overcome. First, one must be able to identify what the scenario trains. The mechanism for achieving this is not complex or new. The system of MPSs in the Marine Corps provides an adequate mechanism for tagging the training objectives of a given scenario. Second, one must be able to identify what is in the scenario. This information is not difficult to organize since it includes standard data that everyone understands such as number of players, number and type of vehicles and weapons, type of terrain, and type of enemy situation. Third, one must be able to provide quality control for the scenarios. A novice's best work may be a useless product for the experienced trainer. Some authority must separate the wheat from the chaff without creating an approval bureaucracy so thick that everyone is scared away. Finally, one must provide quick and easy accessibility. The information age has solved any technical problem in this regard, but the internal administrative issues of military information technology are not designed with quick and easy accessibility in mind. Through DVTE, Marine Corps *VBS 2*™ lives in a computer environment entirely cordoned off from the Internet environment, and the Navy Marine Corps Intranet (NMCI) does not offer easy solutions to this challenge.

With formalization of standard training packages, the Marine Corps training community can implement learning management software to help trainers monitor the unit's progress. We believe that rigid emphasis on such tools can stifle training initiative and create programs that merely put a check in the box. Rather, a learning management tool should provide trainers with a picture of current and desired training levels. Then the tool should recommend ways to make up the difference. Serious games such as *VBS 2*™ lend themselves to such management programs, and these programs would help institutionalize serious games as credible training platforms.

The Joint Training Counter-Improvised Explosive Device Operations Integration Center (JTCOIC) uses *VBS 2*™ extensively. The organization has collected, organized, and documented its *VBS 2*™ models, maps, scripts, and scenarios and makes them available through regular e-mail dissemination. JTCOIC has no charter to act as a DoD *VBS 2*™ clearinghouse, but their efforts at organizing *VBS 2*™ material provide a model for the rest of the military *VBS 2*™ community. Expanding on this model DoD wide could benefit all users exponentially.

2. Making a Serious Game Trainer

In our Experiment 5 comments, we pointed out that a trainer using *VBS 2*™ must be a facilitator, technician, and planner/evaluator or have such personnel on his or her staff. Commanders with DVTE in their inventories must consider personnel when determining how to implement the simulations at their disposal. Certainly, junior enlisted personnel should be trained to fill the technician role of serious game training. Equally as clear, senior SNCOs and junior officers should fill the planner/evaluator role. However, commanders cannot depend on junior enlisted personnel to fill the facilitator role and must ensure that SNCOs and junior officers are suited to either fill this role or closely supervise it. We believe the power of virtual training lies in the judicial application of the facilitator role and the transfer of this role to the trainer. Commanders can guarantee this by getting trainers to DVTE training as well as junior enlisted personnel who will serve as "pucksters."

3. Appreciation of *VBS 2*™ in the Fleet

The generation of officers and upper level federal employees who are buying today's training systems are technically adept and progressive enough to understand that today's youth expect a technically based training experience from the technology revolution. However, they do not necessarily understand this wired generation. The exuberance to appease the young serviceman who has never lived without Internet or computers has led to a variety of assumptions that may not be true and may have never been true. Because of the pace of technological change, the truth behind these assumptions may change too fast to ascertain their validity at any point in time.

For example, one might surmise that today's generation would appreciate personal computer-based gaming for training. This assumption seems to fit with the stereotype of the data-device-wielding teenager. Furthermore, one can find numerous data to support the idea that today's youth play video games. However, data device use does not connote a gamer, and a gamer does not connote appreciation of serious games as training devices. A similar domain illustrates this concept. Almost everyone has seen a movie, most people have seen many movies, and many people enjoy movies as a form of entertainment.

However, that does not mean that Marines enjoy watching military films for training. Even if Marines like movies with military themes, they most likely enjoy qualities of the movie that lend to entertainment rather than realism. We must remember this concept when we consider serious games and today's technophilic youth.

Even for the avid gamer, we cannot assume an immediate appreciation of serious games for training. Often, the gamer is the one who dislikes the training simulation the most. Most people who do not bicycle would consider any bicycle, regardless of style, source, quality, age, or other factors, the same. On the other hand, an avid cyclist would certainly never use a mountain bike for road racing and would quite likely seek the highest end racing bike money could buy if road racing was the objective. Gaming is no different. Different games have different purposes, qualities, and styles. Gamers often bring a set of expectations to the training simulation that the military cannot satisfy in such a dynamic industry. The barracks XBox jockey might be the very person most put off by the personal computer-based simulator chosen by the military service.

In our enthusiastic theorizing about serious games, we might be tempted to imagine a day when military personnel train in virtual environments of their own volition and initiative because they enjoy the game. Our experience in this study showed that, left alone, Marines like to do in a simulation environment what they like to do anywhere else when left alone to their own devices. They like to fool around. They like to work as independent players, getting the best of their mates. They like to have fun. While some of this play may lead to tactical lessons learned, unit training can only be realized through a disciplined application of training developed according to an organized set of objectives. Simulation training cannot eliminate the need for the trainer any more than it can eliminate the need for live training.

We do not record these observations to suggest that personal computer-based training is a lost cause. Quite the contrary, today's military is not surprised that it exists and readily embraces it. Arguably, they expect it and have high standards for it. However, we cannot expect them to appreciate the training simply because we were progressive enough to militarize a computer game. Today's youth expects both technical quality and training quality from the simulation, as they should. This demands an adept trainer who knows how to use the simulation as an extension of his training abilities. It also demands a simulation architecture that can keep up with the times, modernizing training tools at the rate that Marines update the equipment in their barracks rooms and living rooms from the local gaming superstore.

4. Counting Dollars

In Experiment 4, we demonstrated that *VBS 2*™ can train Marines as effectively as traditional means such as the sand table for small unit tactical skills. This work shows why training with serious games should be considered in a resource constrained environment that precludes live training. However, the findings suggest that the trainer can consider traditional training on an equal footing with serious game training. Certainly, when it comes down to dollars and cents, the operational trainer must choose to buy a suite of computers with a vision toward distinct and unique training gain. We believe serious game training offers advantages over traditional training garrison exercises. While we do not propose to use this thesis as a cost analysis vehicle for serious games, we suggest the following advantages of serious game technology.

a. Users Like It

Experiment 4 demonstrated that Marines preferred using *VBS 2*™. Subjectively, Marines felt their tactical skills improved more using *VBS 2*™ than using traditional training methods. Despite unique gamer biases, training aligned with the modern technical age appeals to young warfighters. Marines and soldiers are used to computers in their daily life, and they accept training administered through them. As Experiment 5 demonstrated, this acceptance cannot be taken for granted; Marines still expect quality training in virtual environments like anywhere else. Marines like to train live, but when this is not possible, they like using well administered serious games

b. The After Action Review Tool Expands the Trainer's Options

In live training, the exercise proceeds, and then it is gone. Only memories and notes remain after its completion. Traditional training like the sand table produces the same results. However, serious games such as *VBS 2*™ offer the ability to record the exercise and view it exactly as it happened. As a matter of fact, the trainer can review the exercise from many different perspectives, focusing on points of interest in whatever manner he chooses. This review capability is unique to virtual environments, and it offers the trainer capabilities that cannot be achieved through any other means.

c. Events Are More Real

Virtual training offers the potential for partial, or possibly complete, immersion in the training environment. Trainers cannot achieve anything but the most remote level of immersion using sand tables or tactical decision games. While virtual training environments cannot achieve enough immersion to rival a live exercise, they provide the only opportunity for immersion out of the choices for garrison training. Trainees can experience weapons effects, death, the visual effects of motion, the sounds of combat, and other battlefield effects. While these virtual experiences are certainly far from real, they create a more realistic evolution than traditional means. Arguably, some effects, such as death and injury, are even more real than live training. This unique version of realism demands that serious games be included in tactical training curricula.

d. Training Can Be Standardized

Computers offer dependability that training based on human interaction can never achieve. Once a trainer develops a valid training regimen in a serious game, the trainer can administer the scenario the same way every time. The trainer can export the scenario to other trainers easily. This unique advantage of computer-based training provides the opportunity to align training scenarios with doctrine and then mass produce them for the convenience of many training audiences. Neither live nor traditional training can achieve this level of standardization, and trainers can serve their communities well by capitalizing on this feature.

e. Serious Games Offer Ties to Higher Headquarters

Higher-level command cells, particularly battalion and above, tend to rely more and more on simulation to achieve their training goals. Mobilizing large units for training is costly and manpower intensive. Simulation offers the opportunity for large staffs to exercise procedures and techniques while avoiding these costs. Serious games allow the small unit tacticians to interface with these higher level simulations. Such interoperability sets the stage for a symbiotic relationship. Small units have the benefit of operating in a domain supervised by a higher headquarters with all of its help and hindrances while higher level units have the added chaos of subordinate units making decisions at their level with a thinking mind instead of a computer's artificial intelligence. When the Lieutenants and the Lieutenant Colonel need to train together, simulation offers an outstanding medium to accomplish goals without wasting the valuable time of a whole unit full of Marines or soldiers.

5. Shopping for Serious Games

An interest in the potential of transfer studies as decision drivers in the acquisition of training games partially motivated this thesis effort. When choosing a serious game for training purposes, the military trainer can use four methods to select the appropriate platform. First, the trainer can conduct a training transfer study like the project documented in this thesis to explicitly determine the effectiveness of the platform. Second, one can shop by features, depending on the written catalog descriptions or the verbal explanations of vendors to provide the necessary information to make the decision. Third, the trainer can conduct a user study in which a representative user sample compares several similar platforms and provides comparative subjective evaluations. Fourth, one can use the gut instinct of what looks good based on whatever experience the trainer has accumulated in the domain.

Based on this thesis project as a whole, we conclude that the training transfer study does not adequately support the serious game acquisition process. Quite simply, such a study involves much effort with little return. The process of gaining access to user units, developing satisfactory evaluation mechanisms that produce scientific results without handcuffing the unit's initiative, and following the project through the chaotic demands of operational military life requires much effort, readjustment from missed opportunities, and sheer luck. Furthermore, the results tend to be murky at best. For transfer studies in the group training domain, even the most rigid transfer studies leave gaping holes for the skeptic to launch unanswerable concerns.

The reader should not interpret the preceding paragraph as a suggestion to discard training transfer studies altogether. Training transfer studies potentially offer unique and valuable insight to the research community that no other methodologies can attain. If nothing else, the process of the research project itself results in a well-documented investigation into the specific areas of success and failure of the training tool. However, the slow, arduous, and potentially inconclusive world of training transfer studies will most likely only offer frustration to the decision maker trying to spend Department of Defense dollars on a narrowly defined budget, time schedule, and performance objective set.

The military trainer must decide what systems to buy somehow, and the preceding argument only serves to nay-say one method. We did not structure this thesis project in any way to answer the question at hand, but we feel the lengthy hands-on effort has provided ample qualification to include some notes of opinion on the topic. We start the discussion by stating up front that the answer is not some clean-cut checklist style formula. Rather, a sound serious game acquisition effort will most likely include some aspect of each of the last three selection methods.

Arguably, feature shopping drives the current serious game acquisition process. One simply jots down requirements, reviews vendor descriptions of applicable products, and decides according to some designated cost analysis criteria. The Interservice/Industry, Training, Simulation, and Education Conference (I/ITSEC) offers one of the best opportunities for the military trainer to feature shop. Vendors shamelessly showcase their most innovative contributions to the simulation community with flashy screens, fancy interfaces, and brilliant sound effects. We are not saying I/ITSEC is bad; quite the contrary, I/ITSEC plays an absolutely vital role in educating the military training community about the available market. Nevertheless, the military professional who treats I/ITSEC as a buffet is doomed to come home with an empty pocket and a warehouse of gadgets that will gather dust. Common sense dictates that only a foolish buyer relies exclusively on the advice of sales professionals. One must shop intelligently. Feature shopping is certainly an important part of the process, but this sort of selection method executed exclusively will likely result in overpriced bells and whistles and a deficit of substance.

We illustrate the idea of user studies by visiting the Marine Corps' recent efforts to update the individual fighting gear for Marines. Over the past decade and a half, the Marine Corps has updated virtually all of the personal gear inventory, including packs, sleeping bags, foul weather gear, the utility uniform, and boots. For the most part, Marines contentedly use this gear, happy to have emerged from the outdated world of shelter halves and rubber rain suits. The acquisition program employed a notable technique of user testing for all of this gear. Representative Marine units tested the gear in all sorts of conditions, and the opinions of warfighting Marines literally determined the course of the acquisition effort. This technique produced high quality upgrades that have resulted in improvements to warfighting capability and individual morale.

Certainly, this technique suits the acquisition of serious games as well with one striking exception. A Marine testing a sleeping bag knows that he needs a product that is light, dry, and warm. He knows this from his experience with other sleeping bags. If the Marine had never used a sleeping bag before, he might pick a light sleeping bag that left him wet in a rainstorm or the warmest sleeping bag that weighed too much for practical transport. The Marine's experience with similar products enables him to successfully contribute to the selection process. In the case of serious games, most Marines do not have the requisite experience to know what they want or to know when the product is "good." During this project, we noticed that Marines often judged *VBS 2*™ training either because they liked the novel approach or because the non-traditional approach disturbed them. Either way, serious games for training fell outside their experience base, leaving them unqualified to comment on the quality of the specific platform.

Military decision making does not always occur with a highly structured analytical approach due to time constraints, lack of resources, or other obstacles. In the absence of structured analysis, military professionals often make quick decisions based on available information and relevant experience. The expression "a good seventy percent solution now is better than a perfect one hundred percent solution later" sums up this concept. Because military leaders employ this technique in training and war, one would not be surprised to see them employ it in acquisition. We do not dismiss this technique as inappropriate to the acquisition of serious games. Certainly, the instantaneous impression of a General or Master Gunnery Sergeant with decades of experience can lend more to the selection process in less than sixty seconds than months of analysis. However, such a process employed exclusively has neither the analytical power required by those holding the purse strings nor the breadth to represent every user situation. At its worst, this technique turns into a single individual buying pet toys, and at its best, the method results in rapid turn around that catches the user base off guard and leaves critical people excluded from the process.

For serious game acquisition, this discussion leaves the warfighter in a quandary. If the complexities of measuring team cognition preclude a bona fide effectiveness study, the user must buy systems intelligently some other way. In Section 1, we discussed techniques of making *VBS 2*™ ubiquitous through the Marine Corps' system of schools. The solution to the serious game acquisition effort lies here as well. This thesis demonstrates that serious games can effectively contribute to training. Schools provide the means to quickly get Marines experienced in the employment of serious games for training. Once exposed to serious games and taught how to use them, Marines will develop the requisite experience base to support the user studies and gut instinct buying approaches that can best select the most suitable training platform out of all the competing products on the market.

6. Conservative Use of Options

VBS 2™ allows the user to manipulate a variety of options to enhance the user experience. In this way, one can control whether a participant dies, how the participants' interface works, and a variety of other practical issues. We felt that we should alter these options from the defaults with caution. The Marine Corps intends to make *VBS 2*™ a ubiquitous training asset, and Marines will expect the training device to look the same and operate the same from exercise to exercise and from command to command. To some extent, personalizing training assets allows a Marine to get the most out of the gear, but in an environment of constant turbulence and rotation, there is value in all assets being the same. We did not rule out the idea of tailoring the *VBS 2*™ options to best support our goals, but we took a conservative approach to changing them.

After conducting several training exercises in the series of pilot studies and experiments, we noted some options that we felt necessary to change from the default. In interface training, it is helpful to force all avatars to stay alive regardless of battlefield damage. Despite all attempts at discipline and caution, novice users will accidentally shoot each other. The cost in terms of time and frustration of bringing users back into the environment is not worth the realism for initial training. Of course, once initial training is done, this argument does not hold. For most training exercises, invincibility would almost certainly teach Marines the wrong thing. Invincibility is only useful as a matter of convenience when teaching button pushes.

For the training we conducted, it was helpful to disable the third person view. Likewise, the "M" key allows users to pull up the two-dimensional map view. While the map is quite useful, it depicts enemy locations, so it is an unrealistic asset. We disabled the "M" key function so that users could not see this view. In general, we felt that the best training evolved from users only seeing the world from the first-person view of their position. With this in mind, we paid attention to disable all other views and to position participants so that they could only use their own computer screens to see the environment.

VBS 2™ has a re-spawn capability for avatars that die during the course of the scenario. Avatars re-spawn into swallows that can fly around the local area of their unit observing the action from a third person view. We enabled this function. We found that users who died in the scenario and were doomed to stare at a black screen for the remainder of the exercise got little training and, in some instances, detracted from the training of others. The re-spawn function is quite helpful to remedy this training problem.

7. Not All Terrains Are Created Equal

During the course of our experiments, we noticed a difference between the quality of the Twentynine Palms terrain and the Sahrani terrain. The two terrain databases come from different origins. The Twentynine Palms database hails from Marine Corps specifications, while the Sahrani database satisfies the needs and desires of the gaming community. However, the Twentynine Palms terrain did not offer the same quality of training experience as the Sahrani terrain. Vehicles in the Twentynine Palms terrain maneuvered on roads as though they drove on paved highways instead of the off road trails that exist in reality.

Vehicles in the Twentynine Palms terrain could easily climb mountains that they could not drive on in reality. The microterrain features that characterize the Twentynine Palms landscape, limiting wheeled mobility, were not represented at all. Twentynine Palms is full of rugged rocks, wadis, holes, craters, and other features that make wheeled movement difficult, or sometimes impossible, and wheeled vehicles could move easily across open terrain in the virtual environment database. The Sahrani terrain, on the other hand, provided more realistic roads, hills, microterrain features, and other features. One can debate the level of fidelity needed for useful training, but fidelity must certainly be high when it relates to the specific task being trained. Convoy training revolves around the mobility of forces, and terrain characteristics dramatically impact this mobility. The unit seeking to use Twentynine Palms terrain to support a rehearsal scenario could be sorely disappointed. The unit could very well find that vehicles could not execute a well planned operation because of the realities of the ground.

In this thesis, we do not specifically seek to define which terrain databases are suitable and which are not. We feel it is important that those involved in the development and procurement of terrain databases for *VBS 2*™ evaluate the objectives of the terrain. These people must ensure they write the specifications for *VBS 2*™ terrain to support the potential associated training objectives. Desert terrain can be as simple as a sand colored plane, and a building can be as simple as a textured cube. However, some cubes scattered on a tan plane do not necessarily make adequate terrain for the trainee. On the other hand, the trainee does not necessarily need to see each blade of grass blowing in the wind or the interior of every building in the terrain. The answer lies somewhere between the two, and the arbitrary middle point is a distinct function of potential training objectives. *VBS 2*™ terrain database construction offers a very real potential for waste of money, either in the purchase of terrain that offers unnecessary realism or the development of terrain that is so poor in quality that it is never used.

8. Communications in *VBS 2*™

During this project, we experimented with two software applications to support communications. We used JVTR and CNR SIM. We found that while we could accomplish communications objectives with either, we considered both unsatisfactory for the needs of our project. Quite simply, communications should be as seamless as all other aspects of *VBS 2*™. Communications should be internal to *VBS 2*™ with seams between vendor production transparent to the user. Our current version of *VBS 2*™ has five icons on the startup screen for functions such as setup, networking, editing, and starting a scenario. A user should have an additional icon for communications. From this icon, the user and administrator should be able to access appropriate buttons and toggles and then start the simulation. The amount of headaches associated with JVTR and CNR SIM are not consistent with the rest *VBS 2*™. Our work in this project demonstrated consistently through all five experiments that communications is fundamental to the training experience and one of the most important aspects of the exercise. The communications support for *VBS 2*™ needs immediate attention.

9. Computer Glitches in *VBS 2*™

We noticed a few computer glitches in *VBS 2*™ that bear mention. First, our work in the interface familiarization pilot study discussed in Chapter III revealed that IED disarmament disrupts the AAR recording. As we have mentioned previously, the AAR often provides the bulk of the training value for a *VBS 2*™ exercise. If IED disarmament plays a critical role in the scenario, this problem could limit the training value of the simulation exercise. Likewise, we discussed the problem of a driver and gunner losing control of their avatars in some circumstances in networked scenarios. We found that this problem could be remedied by switching into map view and back out again, but this problem inhibits training. Worse, it usually occurs right in the heat of some action that is the center of the training objective.

We understand that computer glitches such as these have been identified to Bohemia Interactive and will be fixed in later editions of *VBS 2*™. *VBS 2*™ offers a Web site forum for the discussion of such topics. In this forum, users from every sector of the *VBS 2*™ community post lessons learned and interact with the *VBS 2*™ support staff to come up with the best possible answers. This support forum is vital to the ultimate success of *VBS 2*™, because it allows the software package to be a living thing, continuously adapting to the needs of the user. However, it also requires the user to stay attuned to the latest information to provide the best possible training for the unit. Many *VBS 2*™ questions have been asked, and many answers are known, but ensuring the Marine with the question reaches the applicable answer can be a daunting task.

10. Training Notes

We collected a few miscellaneous notes that we feel worthy to document for anyone seeking to follow in our footsteps working with *VBS 2*™ as a training platform. The trainer must consider time. The simplicity of a laptop trainer may tempt one to believe that training can occur on a dime. This is not true, at least initially. We found that twelve computers require approximately one man hour to set up and one man hour start up. This rule of thumb can be circumvented by training the Marines using the system to do the set up and start up procedures, but this requires its own amount of time and potentially subjects the equipment to abuse that is difficult to see and control. Additionally, even the most dedicated Marine can only train with *VBS 2*™ so long before it turns into a game, and a monotonous one at that. Limited training times seem to promote the best training.

The trainer must seriously consider how to ensure trainees take the simulation seriously. It does not take much for *VBS 2*™ to transform from training into a game. However, this is true of live training, or any other training, as well, and the solution to the problem, whether live or simulated, is leadership.

Without the proper leadership in place, the trainer will find that negligent discharges, fratricides, and other practices associated with games rather than training will dominate the exercise.

VBS 2™ is not only a suitable forum for observing trainees, but it provides an opportunity to observe the trainer. Often, the trainer is as much of a novice at training Marines as the Marines are at conducting the training. For the Company Commander seeking insight into how his Platoon Commander trains his Marines or for the Platoon Commander trying to show his new Platoon Sergeant how to train, *VBS 2*™ provides an excellent opportunity to discuss what is important and how to present it to the training audience.

C. RECOMMENDATIONS FOR FUTURE WORK

1. Repeat Experiment 5 to See the Effects of the Trainer

In Experiment 5, we unsuccessfully attempted to compare simulation training exercises in which the trainer implemented training through a third party with exercises administered by the trainer alone. However, our observations provided ample evidence that this domain of study bears further investigation. If a researcher could convince a unit to train Marines in different venues, a comparison study using the unit's DVTE assets versus the same assets in a Simulation Center would shed light on this matter. We believe this question is highly important, because it drives decisions about whether the Marine Corps and other services should field and maintain serious games through operational units or only house and administer them through contractor staffs in base Simulation Centers.

2. Can *VBS 2*™ Scenarios be Catalogued and Classified?

We noted that *VBS 2*™ could move toward ubiquitousness as the user base develops a body of tried and tested scenarios to pass throughout the user community. The less Marines have to invent the wheel, the more inclined they will be to use the tool. Right now, there is no good mechanism to pass *VBS 2*™ scenarios around in a structured, organized way. In order for one Marine to use another Marine's scenario, the Marine must know the purpose of the scenario, the training objectives it should fill, the number of players involved, the type of support involved, and a variety of other information. JTCOIC has made great strides in documenting how they made their scenarios, what they do, and what they look like and has even started including video to support the documentation. Future work could investigate Best Practices for formalizing such documentation so that the operator could select *VBS 2*™ scenario support from a menu, easily matching scenario characteristics to training needs.

3. Do Peripheral Computer Devices Enhance *VBS 2*™ Training?

Currently, the Marine Corps fields *VBS 2*™ with the idea that it will only be used on a laptop with the standard keyboard and mouse interface. One can alter the interface by adding game controllers, larger screens, head mounted displays, more realistic communications interfaces, and other peripheral devices. *VBS 2*™ derives a certain amount of benefit from its easy deployability; at the end of the day, a Marine only needs to move around a laptop and some cables. Future work could investigate the addition of some of these peripheral devices to determine whether they add enough training benefit to justify their cost and added logistical burden.

4. Would a *VBS 2*™ Filming Capability Be Useful for Training?

VBS 2™ shows potential for use as a demonstration tool as well as a practical application tool. A trainer can choreograph an exercise with relative ease to show Marines what "right" looks like. This idea is not novel; the Army used DARWARS Ambush! in this mode (Roberts, Diller, & Schmitt, 2006), and JTCOIC has produced videos to demonstrate its products. However, one cannot easily film *VBS 2*™ exercises for demonstration purposes. The trainer must figure out how to use an external screen capture tool and must do all video editing externally. Future work could investigate whether an internal *VBS 2*™ filming function could provide training benefit and how this video function should be added to the software.

5. When Is the Third-Person View Preferable to the Map View for the Real-Time Editor and After-Action Review Functions?

We noticed that different trainers prefer different views for using the real-time editor and the AAR tool. While the flexibility is convenient for different people to use *VBS 2*™ in their own way, a better understanding of when each view is most useful would be helpful in training the trainer to make the best use of the simulation. Not only must the trainer know which view is best to personally look at the situation and affect training, but the trainer must know the best view to show different battlefield activities when debriefing exercise participants. Future work could investigate how a trainer can best use these different views to provide the most training value.

6. Is There a Potential for Civilian Users of Armed Assault to Contribute to Marine Corps *VBS 2*™ Training Efforts?

In Chapter II, we provided an extensive review of gaming throughout history highlighting the continuing link between civilian leisure gaming and military training. *VBS 2*™ has a rich history in the civilian gaming industry. *VBS 2*™ originated from the *Operation Flashpoint* game engine, and the current civilian version of the game, Armed Assault, is relatively interchangeable with *VBS 2*™. *VBS 2*™ can use models, terrain, scenarios, and scripts developed for Armed Assault. Likewise, Armed Assault can operate with *VBS 2*™ creations. The Armed Assault community is a vibrant group with extensive interaction. Web sites, such as www.armaholics.com, allow Armed Assault users to share their products and benefit from each other's experience. Typically, Armed Assault users seek realism in their gaming and might have an appreciation for something that is very real: military gaming. For example, while the Marine Corps and other DoD agencies have worked on building realistic Afghan terrain databases, Afghan terrain has shown up on www.armaholics.com. Taken to the extreme, civilian Armed Assault players could present the ultimate oppositional force by playing Marines or soldiers in their own game. Future work could explore whether the military could leverage the civilian gaming community for mutually beneficial products, thereby gaining training assets for free.

7. Who Is This New Computer Generation and What Do They Expect?

The simulation training community has been quick to tout simulation training as a way to capitalize on the technical expertise of the youth filling our junior enlisted ranks, who have never lived in a time without computers. We have discussed the idea that these young people may not all have the gaming expertise or appreciation for gaming that we think they do. Moreover, this appreciation of technology may not spread equally across ranks, age groups, military services or components, or job specialties. For example, a young communicator reservist may appreciate serious games for training more than an active duty infantryman regularly training in the field. We have seen enough of this issue discussed first-hand to highly recommend a demographic mapping of the Marine Corps in terms of computer gaming expertise and appreciation. An organized pursuit of serious games for training's sake hinges on an understanding of the people who will use it. We cannot properly design interfaces, train users, write manuals, or field systems without a better understanding of the Marine sitting at the keyboard. This study has the potential to extend far beyond the bounds of serious games, as the DoD investigates the potential of unmanned equipment on the battlefield, bringing serious gaming and reality in dangerous proximity to each other.

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APPENDIX A. INFORMED CONSENT (EXPERIMENT 1)

Informed Consent Form

Introduction. You are invited to participate in a research study entitled Virtual Battlespace 2 User Familiarity Pilot Study. This study supports a project to compare the training effectiveness of a first-person shooter simulation with traditional tactical training methods such as the sand table. This pilot study tests procedures to familiarize users with the simulation.

Procedures. The simulation familiarization will consist of the following:

- Survey to better understand the user's level of computer expertise;
- Overview brief describing the project and the pilot study's purpose;
- User interface brief describing the basic functions of the simulation;
- User experimentation period, where participants will be able to freely test the ideas just presented;
- User evaluation, where participants will complete a short exercise demonstrating their skill level with the simulation.

The pilot study will take no longer than the 50-minute class period.

R**isks.** The potential risks of participating in this study are not greater than minimal risk. The study involves no known reasonably foreseeable risks or hazards greater than those encountered in everyday life.

Benefits. The anticipated benefit from this study is gaining insight into the viability of first-person shooter simulations as tactical training devices.

Compensation. No tangible compensation will be given. A copy of the research results will be available at the conclusion of the experiment. If you would like a copy of the results, e-mail Major Ben Brown at bjbrown@nps.edu.

Confidentiality & Privacy Act. Any information that is obtained during this study will be kept confidential to the full extent permitted by law. All efforts, within reason, will be made to keep your personal information in your research record confidential but total confidentiality cannot be guaranteed. No information which could identify a participant will be publicly accessible. Records of participation will be maintained by NPS for 3 years, after which they will be destroyed. However, it is possible that the researcher may be required to divulge information obtained in the course of this research to the subject's chain of command or other legal body.

Voluntary Nature of the Study. Participation in this study is strictly voluntary, and if agreement to participation is given, it can be withdrawn at any time without prejudice.

Points of Contact. It is understood that should any questions or comments arise regarding this project, or a research related injury is received, the Principal Investigator, Dr. William J. Becker, 656-3963, wjbecker@nps.edu should be contacted. Any other questions or concerns may be addressed to the Navy Postgraduate School. IRB Chair, LCDR Paul O'Connor , 831-656-3864, peoconno@nps.edu.

Statement of Consent. I have read the information provided above. I have been given the opportunity to ask questions and all the questions have been answered to my satisfaction. I have been provided a copy of this form for my records and I agree to participate in this study. I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

Participant’s Signature Date

Researcher’s Signature Date

APPENDIX B. IRB REQUEST (EXPERIMENT 1)

William J. Becker, Ph.D.
MOVES Institute
Watkins Hall
Naval Postgraduate School
Monterey, California 93943

831-656-3963
DSN: 756-3963
Fax: 831-656-7599
wjbecker@nps.edu

To: Protection of Human Subjects Committee

Subject: Application for Human Subjects Review (Title): Virtual Battlespace 2 User Familiarity Pilot Study

PROJECTED START DATE: 02 / 16 / 2009
MONTH DAY YEAR

I am requesting approval of the attached experimental protocol. The following documentation is provided in support of my application.

The Principal Investigator understands and accepts the following obligations to protect the rights and welfare of research subjects in this study:

- I recognize that as the Principal Investigator it is my responsibility to ensure that this research and the actions of all project personnel involved in conducting this study will conform with the IRB approved protocol and IRB requirements/policies.
- I recognize that it is my responsibility to ensure that valid informed consent / assent (unless explicitly waived by the IRB) has been obtained from all research subjects or their legally authorized representatives. I will ensure that all project personnel involved in the process of consent are trained properly and are fully aware of their responsibilities relative to obtaining informed consent / assent according to the IRB guidelines.
- I will ensure all personnel involved in this study have completed the required IRB Training.
- I will not initiate any change in protocol without IRB approval.
- I have no conflict of interest negating me from performing this research.
- I will maintain all required research records on file; and I recognize that the IRB is authorized to inspect these records at any time.
- I will immediately inform the IRB Chair and NPS Dean of Research of any untoward event or injury that involves a research participant.
- I understand that in the absence of a continuing review and approval, this research may not continue beyond the end of the approval period.
- At the completion of this project, an End-of-Experiment Report will be submitted.
- I will not commence this research, including subject recruitment, until I have received my NPS IRB application approval letter.

____
(Signature of Principal Investigator)

Dr. William J. Becker

Application for Human Subjects Review	NPS IRB Number:
Principal Investigator(s): Co- PI(s)	Dr. William J. Becker, Professor, 831-656-3963 Major Benjamin J. Brown, Student, 831-656-3812
Title of Experiment:	Virtual Battlespace2 User Familiarity Pilot Study

Approval Requested [X] New [ ] Continuing [ ] Amendment

Requested Level of Risk [ ] Exempt [X] Minimal [ ] More than Minimal
Justification: The participants will be asked to use virtual training simulation on laptop computers, which is a standard practice for this curriculum.

Work to be done in (Site/Bldg/Rm) Watkins 275 / 285	Estimated date of completion (not to exceed one year from start date): 30 Sept 2009
Maximum number of subjects: 50	Estimated length of each subjects participation: 50 minutes

Special Populations that will be Used as Participants:

[ ] Subordinates [ ] Minors [X] NPS Students [ ] Special Needs (e.g. Pregnant women)

Specify safeguards to avoid undue influence and protect subject's rights:
- Participation is voluntary, and each participant will have the option to withdraw from the study at any time.
- Participants will be informed that class credit is not involved in the study either for participation or for lack of it.
- The data collected in the study will be safeguarded as requested by generally accepted IRB standards: each person will be identified only as a code number on all research forms and databases; the name of any person on any signed document will not be paired with the code number in order to protect identity; and records of the participant's participation will be maintained by NPS for 3 years, after which they will be destroyed.

Scientific Merit Review (Check all that apply)

[X] This research is part of a funded project (Job Order Number: R9554)

[ ] This research is a student thesis (Attach a copy of the approved thesis proposal)

[ ] Other (Attach a complete research proposal - Dept. Chair must sign Application Cover Letter)

Outside Cooperating Investigators and Agencies:
None

[ ] A copy of the cooperating institution's POC and CO's approval is attached.

Description of Research: (attach an additional sheet if needed). The purpose of the pilot study is to test a procedure to familiarize users with Virtual Battlespace 2 (*VBS 2*). *VBS 2* is a personal computer-based first-person shooter simulation used by the Marine Corps. The simulation is installed under contract on Dell XPS computers and deployed in suites of 16 to operational infantry units. NPS has 6 such computers, and an additional suite of 16 have been obtained for this project. These computers will be used for the pilot study. The pilot study anticipates a training transfer study of Virtual Battlespace 2 using a platoon-level convoy exercise.

Simulation familiarization will consist of the following:

- Survey to better understand the user's level of computer expertise;
- Overview brief describing the project and the pilot study's purpose;
- User interface brief describing the basic functions of the simulation;
- User experimentation period, where participants will be able to freely test the ideas just presented;
- User evaluation, where participants will complete a short exercise demonstrating their skill level with the simulation.

For the study, students will be randomly assigned to groups of 3 to participate as a HMMWV crew in the positions of vehicle commander, driver, and gunner. Tasks to be evaluated include driving, navigating, mounting and dismounting the vehicle, employing the vehicle's machine gun, and employing personal weapons. The pilot study will take no longer than a 50-minute class period.

Method of Subject Recruitment: (attach an additional sheet if needed). Professor John Falby has offered to solicit his MV3922 class for volunteers for the pilot study. The class is a seminar environment, so students will have no pressure to participate in the study for class credit. Additional volunteers will be recruited by e-mail from the remaining pool of MOVES students.

I have read and understand NPS policy on the Protection of Human Subjects. If there are any changes in any of the above information or any changes to the attached materials, I will suspend the experiment until I obtain new IRB approval.

SIGNATURE____ DATE________________

SIGNATURE____ DATE________________

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APPENDIX C. INFORMED CONSENT (EXPERIMENTS 2 AND 3)

Informed Consent Form

Introduction. You are invited to participate in a research study entitled Virtual Battlespace 2 Scenario Testing Pilot Study. This study supports a project to compare the training effectiveness of a first-person shooter simulation with traditional tactical training methods such as the sand table. This pilot study tests computer simulation scenarios used for the tactical training.

Procedures. The simulation familiarization will consist of the following:

- Survey to better understand the user's level of computer expertise, relevant tactical experience, and attitudes toward simulation for tactical training;
- Overview brief describing the project and the pilot study's purpose;
- User interface brief describing the basic functions of the simulation;
- User experimentation period, where participants will be able to freely test the ideas just presented;
- User evaluation, where participants will complete a short exercise demonstrating their skill level with the simulation.
- Overview brief of tactics, techniques, and procedures relevant to the computer exercise.
- Simulation exercise to train small unit convoy immediate action drills.
- Simulation exercise to test small unit convoy immediate action drills.
- Surveys to determine the user's impression of the simulation training.

The pilot study will take no longer than one training day (8 hours).

R**isks.** The potential risks of participating in this study are not greater than minimal risk. The study involves no known reasonably foreseeable risks or hazards greater than those encountered in everyday life.

Benefits. The anticipated benefit from this study is gaining insight into the viability of first-person shooter simulations as tactical training devices.

Compensation. No tangible compensation will be given. A copy of the research results will be available at the conclusion of the experiment. If you would like a copy of the results, e-mail Major Ben Brown at bjbrown@nps.edu.

Confidentiality & Privacy Act. Any information that is obtained during this study will be kept confidential to the full extent permitted by law. Simulation sessions will be recorded using the system After Action Review tool, but the recording only shows generic avatar representations of participants thereby guaranteeing anonymity. All efforts, within reason, will be made to keep your personal information in your research record confidential but total confidentiality cannot be guaranteed. No information which could identify a participant will be publicly accessible. Records of participation will be maintained by NPS for 3 years, after which they will be destroyed. However, it is possible that the researcher may be required to divulge information obtained in the course of this research to the subject's chain of command or other legal body.

Voluntary Nature of the Study. Participation in this study is strictly voluntary, and if agreement to participation is given, it can be withdrawn at any time without prejudice.

Points of Contact. It is understood that should any questions or comments arise regarding this project, or a research related injury is received, the Principal Investigator, Dr. William J. Becker, 831-656-3963, wjbecker@nps.edu should be contacted. Any other questions or concerns may be addressed to the Navy Postgraduate School. IRB Chair, LCDR Paul O'Connor , 831-656-3864, peoconno@nps.edu.

Statement of Consent. I have read the information provided above. I have been given the opportunity to ask questions and all the questions have been answered to my satisfaction. I have been provided a copy of this form for my records and I agree to participate in this study. I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

____ ____________________
Participant's Signature Date

____ ____________________
Researcher's Signature Date

APPENDIX D. IRB REQUEST (EXPERIMENTS 2 AND 3)

William J. Becker, Ph.D.
MOVES Institute
Watkins Hall
Naval Postgraduate School
Monterey, California 93943

831-656-3963
DSN: 756-3963
Fax: 831-656-7599
wjbecker@nps.edu

To: Protection of Human Subjects Committee

Subject: Application for Human Subjects Review (Title): Virtual Battlespace 2 Scenario Testing Pilot Study

PROJECTED START DATE: 04 / 16 / 2009
MONTH DAY YEAR

I am requesting approval of the attached experimental protocol. The following documentation is provided in support of my application.

The Principal Investigator understands and accepts the following obligations to protect the rights and welfare of research subjects in this study:

- I recognize that as the Principal Investigator it is my responsibility to ensure that this research and the actions of all project personnel involved in conducting this study will conform with the IRB approved protocol and IRB requirements/policies.
- I recognize that it is my responsibility to ensure that valid informed consent / assent (unless explicitly waived by the IRB) has been obtained from all research subjects or their legally authorized representatives. I will ensure that all project personnel involved in the process of consent are trained properly and are fully aware of their responsibilities relative to obtaining informed consent / assent according to the IRB guidelines.
- I will ensure all personnel involved in this study have completed the required IRB Training.
- I will not initiate any change in protocol without IRB approval.
- I have no conflict of interest negating me from performing this research.
- I will maintain all required research records on file; and I recognize that the IRB is authorized to inspect these records at any time.
- I will immediately inform the IRB Chair and NPS Dean of Research of any untoward event or injury that involves a research participant.
- I understand that in the absence of a continuing review and approval, this research may not continue beyond the end of the approval period.
- At the completion of this project, an End-of-Experiment Report will be submitted.
- I will not commence this research, including subject recruitment, until I have received my NPS IRB application approval letter.

(Signature of Principal Investigator)

Dr. William J. Becker

Application for Human Subjects Review	NPS IRB Number:
Principal Investigator(s): Co- PI(s)	Dr. William J. Becker, Professor, 831-656-3963 Major Benjamin J. Brown, Student, 831-656-3812
Title of Experiment:	Virtual Battlespace2 Scenario Testing Pilot Study

Approval Requested [X] New [ ] Continuing [ ] Amendment

Requested Level of Risk [ ] Exempt [X] Minimal [ ] More than Minimal
Justification: The participants will be asked to use virtual training simulation on laptop computers, which is a standard practice for this curriculum.

Work to be done in (Site/Bldg/Rm) Unit's classroom on site	Estimated date of completion (not to exceed one year from start date): 31 Dec 2009
Maximum number of subjects: 100	Estimated length of each subjects participation: 8 hours

Special Populations that will be Used as Participants:

[ ] Subordinates [ ] Minors [ ] NPS Students [ ] Special Needs (e.g. Pregnant women)

Specify safeguards to avoid undue influence and protect subject's rights:
- Participation is voluntary, and each participant will have the option to withdraw from the study at any time.
- Participants will be informed that class credit is not involved in the study either for participation or for lack of it.
- The data collected in the study will be safeguarded as requested by generally accepted IRB standards: each person will be identified only as a code number on all research forms and databases; the name of any person on any signed document will not be paired with the code number in order to protect identity; and records of the participant's participation will be maintained by NPS for 3 years, after which they will be destroyed.
- The simulation system After Action Review tool will be used to record simulation sessions. The tool uses generic avatar representations of participants thereby guaranteeing anonymity.

Scientific Merit Review (Check all that apply)

[X] This research is part of a funded project (Job Order Number: R9554)

[ ] This research is a student thesis (Attach a copy of the approved thesis proposal)

[ ] Other (Attach a complete research proposal - Dept. Chair must sign Application Cover Letter)

Outside Cooperating Investigators and Agencies:
None

[ ] A copy of the cooperating institution's POC and CO's approval is attached.

Description of Research: (attach an additional sheet if needed). The purpose of the pilot study is to test small unit tactical convoy training scenarios in Virtual Battlespace 2 (*VBS 2*). *VBS 2* is a personal computer-based first-person shooter simulation used by the Marine Corps. The simulation is installed under contract on Dell XPS computers and deployed in suites of 32 to operational infantry units. NPS has one of these 32 computer suites for this project. These computers will be used for the pilot study. The pilot study anticipates a training transfer study of Virtual Battlespace 2 using a platoon-level convoy exercise.

Simulation familiarization will consist of the following:

- Survey to better understand the user's level of computer expertise, relevant tactical experience, and attitudes toward simulation for tactical training;
- Overview brief describing the project and the pilot study's purpose;
- User interface brief describing the basic functions of the simulation;
- User experimentation period, where participants will be able to freely test the ideas just presented;
- User evaluation, where participants will complete a short exercise demonstrating their skill level with the simulation.
- Overview brief of tactics, techniques, and procedures relevant to the computer exercise.
- Simulation exercise to train small unit convoy immediate action drills.
- Simulation exercise to test small unit convoy immediate action drills.
- Surveys to determine the user's impression of the simulation training.

For the study, Marines will be assigned to crews of 3 to participate as a HMMWV crew in the positions of vehicle commander, driver, and gunner. Vehicles will operate in convoys of 5 to 9 vehicles The pilot study evaluates three convoy training scenarios: a user familiarity scenario, an immediate action drill training scenario, and a computer simulation replication of a live Marine Corps convoy training course. The study uses the simulation's After Action Review tool and user surveys to determine the effectiveness of the training scenarios and troubleshoot scenario design for future work. The pilot study will take no longer than one training day.

Method of Subject Recruitment: (attach an additional sheet if needed). A Marine Corps unit will be solicited for volunteers for the pilot study. Participant solicitation will be effected through the unit's leadership. Active duty and reserve units will be recruited by personal contact to the command staff of each unit. Command staff will decide who, what, and where units will participate.

I have read and understand NPS policy on the Protection of Human Subjects. If there are any changes in any of the above information or any changes to the attached materials, I will suspend the experiment until I obtain new IRB approval.

SIGNATURE_______________________________________ DATE________________

SIGNATURE_______________________________________ DATE________________

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APPENDIX E. VBS 2™ CHEAT SHEET (EXPERIMENT 1)

General	
Move forward	W ↑
Move backward	S ↓
Move left	A ←
Move right	D →
Action Menu	[
INDIVIDUAL	
Run	Shift W
Free look	L Alt + L Alt
Lean left	Q
Lean right	E
Crouch	X
Prone	Z
Stand	C
PERSONAL GEAR	
Fire weapon / Throw grenade	Left click
Cycle weapons	Space bar
Reload	R
Sights	V
Lower / Raise weapon	L Ctrl + L Ctrl
Time	T
GPS	R Ctrl + M
Night vision	N
Binoculars	B
Compass	G
VEHICLE	
Interact with vehicle	U
Forward, low gear	Q
Forward, fast gear	E
Brake	S (Back up)
Get out of the vehicle	H + H
OBJECTS	
Recover casualty	[+ “Carry body” [+ “Put body into vehicle”
Recover vehicle	Get in front (< 15 m) U + Tow icon
Disable IED	[+ “Disarm bomb”

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APPENDIX F. VBS 2™ CHEAT SHEET (EXPERIMENTS 2 - 5)

MOVEMENT	
Move Forward	W
Move Backward	S
Move Left	A
Move Right	D
Action Menu	[
Run	Shift + W
Look Around	Alt + L
Lean Left	Q
Lean Right	E
Crouch	X
Prone	Z
Stand	C

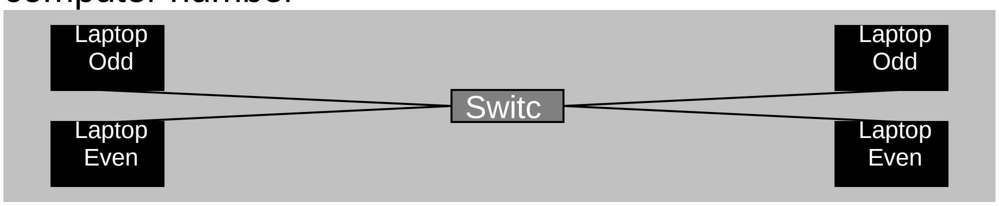
VEHICLE	
Interact with vehicle	U
Forward, low gear	Q
Forward, fast gear	E
Brake/ Backup	S
Get out of the vehicle	H + H

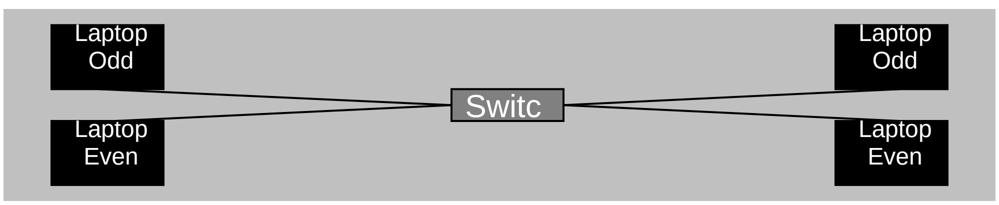
PERSONAL GEAR	
Fire Weapon / Throw Grenade	Left click
Change Weapon	Space bar
Reload	R
Sights	V
Lower / Raise weapon	Ctrl + L
Time	T
GPS	Ctrl + M
Night Vision	N
Binoculars	B
Compass	G

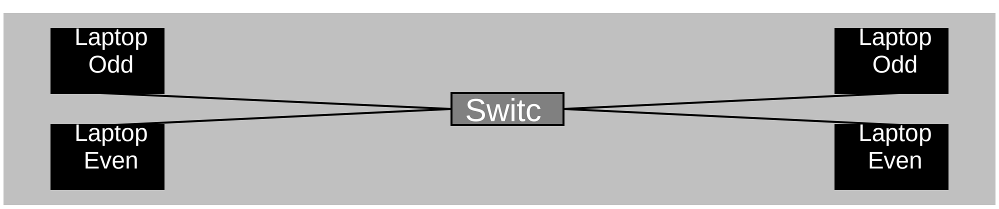
OBJECTS	
Recover casualty	***(1)*** **[+** ***select "Carry body"*** ***(2)*** **[+** ***select "Put body into vehicle"***
Recover Vehicle	***(1) Get in front of vehicle ≤ 15 m*** ***(2)*** **U +** ***select tow icon***

APPENDIX G. FAMILIARITY PILOT STUDY PREPARATION

- Computer setup
  - 6 groups of 2 computers:
    - Connect each box of 4 computers together on a table with the box's switch
  - On the screen of each computer is a number: 113-X; X is the computer number







- Use 5’ and 12’ cables to connect to switch
- Only unwind outlet end of power cords for each computer
- Do not unwind mouse cord; plug in as is
- Use one power strip for each set of computers
- Start all computers with “Instructor”, password InstructDVTE
    - Odd computers: Start VTK Admin
    - Even computers: Start VTK User; Fill in nickname as computer number
- All computers to Networking

- Starting the scenario
    - Odd computers: Go to “New” and click on “Familiarity”
    - Even computers: Join the odd computer’s scenario (make sure it is the computer in its pair
    - Odd computers: Click OK and when Even comes up Continue
    - Note that all 4 computers will show up together with two separate Familiarity scenarios
- Monitoring the scenario
    - When evaluation starts, start recording on odd computer (ESC-Real Time Editor-Click red button in upper right corner)
    - If someone gets the map, they clicked the M key; hit ESC to get back to normal user view
- Cleanup
    - SAVE THE AAR: ESC-Real Time Editor-Click red button in upper right corner
        - Save as Pilot_Familiarity_X_Y where X and Y are the two computer numbers
    - Ensure a survey form is collected for each computer
    - Wind up all cords
    - Ensure computers go back to proper box

APPENDIX H. FAMILIARITY PILOT STUDY QUESTIONNAIRE

Please fill in the following questionnaire. All information will be held confidential. If you need to expand any answer, please use the comments section on the reverse side of your paper.

1. Were you required to use computer-based simulations as part of your training in the past?

   NO / **YES** (circle one)

If **YES**, what simulations have you used, and what skills were they used to train (for example, first-person shooter, flight simulator, operational tactics, etc.)?____________________________

____

____

2. Do you have experience playing commercial video games?

   NO / **YES** (circle one)

If **YES**, what games have you played, and what kind of games were they (for example, first-person shooter, flight simulation, sports, fantasy, etc.)?__________________________________

____

____

If **YES**, how often do you use video games?

Approximately _______ hours per day / week / month / year (circle one)

3. Do you own a personal computer?

   NO / **YES** (circle one)

If **YES**, how often do you use the computer?

Approximately _______ hours per day / week / month / year (circle one)

4. What hand do you use to operate a computer mouse?

   LEFT / **RIGHT** / **EITHER** (circle one)

5. How often do you use the following computer applications? (please answer all that apply)

   a. E-mail: Approximately _______ hours per day / week / month / year (circle one)

   b. Browse web: Approximately _______ hours per day / week / month / year (circle one)

   c. Video: Approximately _______ hours per day / week / month / year (circle one)

   d. Music: Approximately _______ hours per day / week / month / year (circle one)

   e. MS Word: Approximately _______ hours per day / week / month / year (circle one)

   f. MS Other: Approximately _______ hours per day / week / month / year (circle one)

6. Participant Number: ____

7. Date: ____

8. Year of birth: ____

9. Service component: ____

10. Primary MOS or job specialty: ____

11. Rank: ____

12. Time in service: ___________years ___________months **** TURN PAPER OVER**

13. Circle your role in the evaluation exercise: DRIVER GUNNER (circle one)

14. How many targets did you see in the evaluation? Personnel__________ Vehicle__________

15. Without consulting the cheat sheet, what key do you use to drive a vehicle forward?________

16. Briefly describe the steps to tow a vehicle. ____

____

____

17. What task was hardest for you? ____

____

18. What task was easiest for you? ____

____

19. Rate your confidence in doing the following tasks in the simulation by checking one block for each task (**1** means you are **NOT** confident; **5** means you are **HIGHLY** confident):

	1	**2**	**3**	**4**	**5**
Body movements (walking, lying in prone, etc.)					
Vehicle movements					
Shooting your rifle					
Shooting vehicle mounted machine gun					
Recovering a casualty					
Recovering a vehicle (towing)					
Disarming an IED					

20. Do you have any suggestions for improving user familiarization training?

____

____

____

Comments: ____

____

____

____

____

____

____

____

____

____

____

Thank you for volunteering to participate in this study.

APPENDIX I. FAMILIARITY FOLLOW UP EVALUATION

Participant number

When instructed to begin, perform the following tasks in order:

1. Shoot the enemy combatant.
2. Board HMMWV
3. Drive to enemy combatant.
4. Dismount HMMWV.
5. Load enemy combatant's body into HMMWV.
6. Engage truck target with grenade.
7. Assume prone position.
8. Engage near Echo silhouette target in semi-automatic rifle mode.
9. Engage far Echo silhouette target in semi-automatic rifle mode.
10. Stand up.
11. Use simulation watch and write time:

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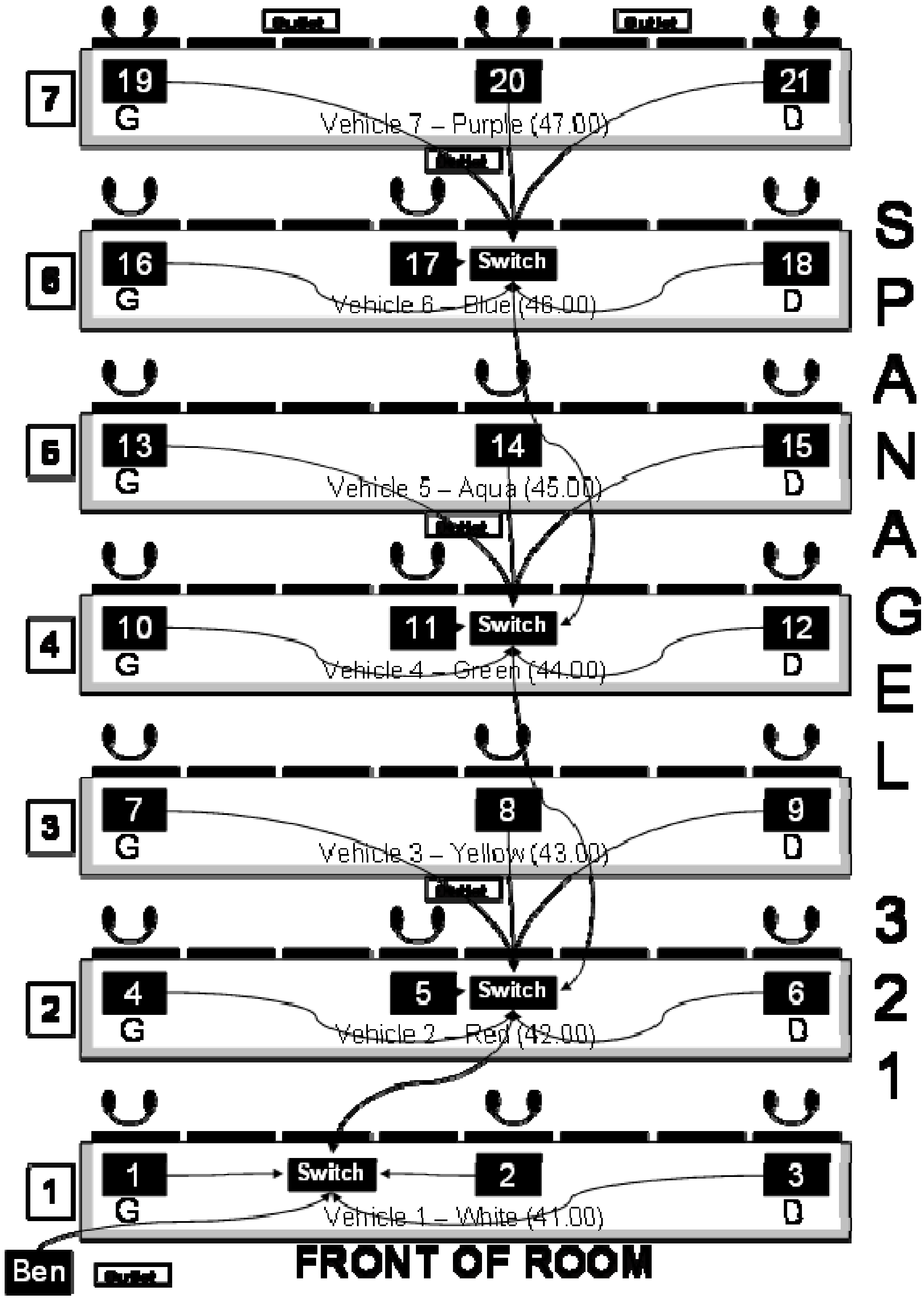
APPENDIX J. MOVES PILOT STUDY ROOM SETUP



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APPENDIX K. WFTBN PILOT STUDY SCHEDULE

0800 – 0815	Administration Informed Consent Demographic Questionnaire
0815 – 0915	Familiarity
0915 – 0925	Break
0925 – 0930	Familiarity Test
0930 – 0950	Convoy Express 101
0950 – 1005	Knowledge Test 1
1005 – 1015	Break
1015 – 1030	Mission Brief
1030 – 1045	Mission Planning
1045 – 1100	Training Wheels
1100 – 1130	Noble Pass
1130 – 1230	Lunch
1230 – 1245	Debrief Noble Pass Post Questionnaire 1
1245 – 1300	Mission Planning
1300 – 1400	Rainbow Canyon
1400 – 1430	Reward Exercise Catch up Gays Pass
1430 – 1450	Knowledge Test 2 Post Questionnaire 2

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APPENDIX L. DEMOGRAPHIC SURVEY (EXPERIMENTS 2 - 3)

Please fill in the following questionnaire. All information will be held confidential.

1. Were you required to use computer-based simulations as part of your training in the past?

   NO / **YES** (circle one)

If **YES**, what simulations have you used, and what skills were they used to train (for example, first-person shooter, flight simulator, operational tactics, etc.)?______________________________

____

____

2. Do you have experience playing commercial video games?

   NO / **YES** (circle one)

If **YES**, what games have you played, and what kind of games were they (for example, first-person shooter, flight simulation, sports, fantasy, etc.)?____________________________________

____

____

If **YES**, how often do you use video games?

   Approximately _______ hours per day / week / month / year (circle one)

3. Do you own a personal computer?

   NO / **YES** (circle one)

4. How often do you use a computer off duty?

   Approximately _______ hours per day / week / month / year (circle one)

5. How often do you use a computer on duty?

   Approximately _______ hours per day / week / month / year (circle one)

6. What hand do you use to operate a computer mouse?

   LEFT / **RIGHT** / **EITHER** (circle one)

7. How often do you use the following computer applications? (please answer all that apply)

   a. E-mail: Approximately _______ hours per day / week / month / year (circle one)

   b. Browse web: Approximately _______ hours per day / week / month / year (circle one)

   c. Video: Approximately _______ hours per day / week / month / year (circle one)

   d. Music: Approximately _______ hours per day / week / month / year (circle one)

   e. Word: Processor Approximately _______ hours per day / week / month / year (circle one)

   f. Other: Approximately _______ hours per day / week / month / year (circle one)

8. Year of birth: ____

9. Primary MOS or job specialty: ____

10. Rank: ______________________________Service: ____________________

11. Time in service: ___________years ___________months **** TURN PAPER OVER**

12. How many times have you deployed to a combat theater?____________________________

13. If you deployed to a combat theater, did you ever participate in convoy operations as a driver, assistant driver, or vehicle gunner?

NO / **YES** (circle one)

If **YES**, approximately how many?____

14. How long have you served with your current unit? ___________years ___________months

16. Rate your agreement with the following statements by marking an X in one block for each:

	DISAGREE 1	2	3	4	**AGREE** 5
Computer-based simulation is an effective training tool.					
Today's planned computer-based simulation training will improve my ability to conduct convoy operations.					
Today's planned computer-based simulation training will improve my unit's ability to conduct convoy operations.					
I think a unit should use computer-based simulation in its tactical training.					

17. Write the number of times you have used a sand table or computer-based simulation for each of the following and mark your preference:

	# Sand Table	**# Simulation**	**Preference (circle one)**
Training			Sand table / Simulation
Mission Planning			Sand table / Simulation
Mission Briefing			Sand table / Simulation
Mission Rehearsal			Sand table / Simulation

18. Rate your knowledge of the following small unit convoy tactics, techniques, and procedures by marking an X in one block for each skill:

	NOT AT ALL PROFICIENT 1	2	3	4	**VERY PROFICIENT** 5
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					

APPENDIX M. DEMOGRAPHIC SURVEY (EXPERIMENT 4)

Please fill in the following questionnaire. All information will be held confidential.

1. Were you required to use computer-based simulations as part of your training in the past?

    NO / **YES** (circle one)

If **YES**, what simulations have you used, and what skills were they used to train (for example, first-person shooter, flight simulator, operational tactics, etc.)?______________________________

____

____

2. Do you have experience playing commercial video games?

    NO / **YES** (circle one)

If **YES**, what games have you played, and what kind of games were they (for example, first-person shooter, flight simulation, sports, fantasy, etc.)?____________________________________

____

____

If **YES**, how often do you use video games?

    Approximately _______ hours per day / week / month / year (circle one)

3. Do you own a personal computer?

    NO / **YES** (circle one)

4. How often do you use a computer <u>off duty</u>?

    Approximately _______ hours per day / week / month / year (circle one)

5. How often do you use a computer <u>on duty</u>?

    Approximately _______ hours per day / week / month / year (circle one)

6. What hand do you use to operate a computer mouse?

    LEFT / **RIGHT** / **EITHER** (circle one)

7. How often do you use the following computer applications? (please answer all that apply)

    a. E-mail: Approximately _______ hours per day / week / month / year (circle one)

    b. Browse web: Approximately _______ hours per day / week / month / year (circle one)

    c. Video: Approximately _______ hours per day / week / month / year (circle one)

    d. Music: Approximately _______ hours per day / week / month / year (circle one)

    e. Word: Processor Approximately _______ hours per day / week / month / year (circle one)

    f. Other: Approximately _______ hours per day / week / month / year (circle one)

8. Year of birth: ____

9. Primary MOS or job specialty: ____

10. Rank: ______________________________________Service: __________________________

11. Time in service: ____________years ____________months **** TURN PAPER OVER**

12. How many times have you deployed to a combat theater?____________________________

13. If you deployed to a combat theater, did you ever participate in convoy operations as a driver, assistant driver, or vehicle gunner?

NO / **YES** (circle one)

If **YES**, approximately how many?____

14. How long have you served with your current unit? ___________years ___________months

16. Rate your agreement with the following statements by marking an X in one block for each:

DISAGREE **AGREE**

	1	**2**	**3**	**4**	**5**
Computer-based simulation is an effective training tool.					
Today's planned computer-based simulation training will improve my ability to conduct convoy operations.					
Today's planned computer-based simulation training will improve my unit's ability to conduct convoy operations.					
I think a unit should use computer-based simulation in its tactical training.					

17. Write the number of times you have used a sand table or computer-based simulation for each of the following and mark your preference:

	# Sand Table	**# Simulation**	**Preference (circle one)**
Training			Sand table / Simulation
Mission Planning			Sand table / Simulation
Mission Briefing			Sand table / Simulation
Mission Rehearsal			Sand table / Simulation

18. Rate your knowledge of the following small unit convoy tactics, techniques, and procedures by marking an X in one block for each skill:

	NOT AT ALL PROFICIENT 1	2	3	4	VERY PROFICIENT 5
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					

19. Rate your unit's knowledge of the following small unit convoy tactics, techniques, and procedures by marking an X in one block for each skill:

	NOT AT ALL EFFECTIVE 1	2	3	4	VERY EFFECTIVE 5
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					

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APPENDIX N. POST-TRAINING SURVEY (EXPERIMENTS 2 - 4)

1. Circle your role in the evaluation exercise: DRIVER GUNNER OTHER (circle one)

If you were not a driver or gunner, what was your role?_________________________________

2. Rate your agreement with the following statements by marking an X in one block for each:

DISAGREE **AGREE**

	1	**2**	**3**	**4**	**5**
Computer-based simulation is an effective training tool.					
Today's computer-based simulation training improved <u>my</u> ability to conduct small unit tactical convoy operations.					
Today's computer-based simulation training improved <u>my unit's</u> ability to conduct small unit tactical convoy operations.					
I think a unit should use computer-based simulation in its tactical training.					

3. If you had to choose a single training medium, would you prefer to prepare for a small unit tactical convoy using a sand table or a computer-based simulation?

SAND TABLE / **COMPUTER SIMULATION** (circle one)

4. Rate your knowledge of the following small unit convoy tactics, techniques, and procedures by marking an X in one block for each:

NOT AT ALL PROFICIENT **VERY PROFICIENT**

	1	**2**	**3**	**4**	**5**
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					

5. Rate the effectiveness of this computer simulation exercise in improving your unit's performance by marking an X in one block for each skill:

	NOT AT ALL EFFECTIVE 1	2	3	4	**VERY EFFECTIVE** 5
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					

6. Rate your agreement with the following statements by marking an X in one block for each:

	DISAGREE 1	2	3	4	**AGREE** 5
This training mission was successful.					
During this exercise, I felt like my actions in the virtual environment had no consequences.					
During this exercise, I felt like I was playing a game.					
During this exercise, I felt like I was conducting training.					
During this exercise, I felt like I was part of the group working together.					
During this exercise, I felt isolated from the others.					
This computer simulation provided sufficient audio cues for me to know what was going on.					
This computer simulation provided sufficient visual cues for me to know what was going on.					
The training value of this exercise came from the debriefing and not the exercise itself.					

7. What task was hardest for you? ____

____

8. What task was easiest for you? ____

____

9. What task was hardest for your vehicle crew? ____________________________________

____

10. What task was easiest for your vehicle crew? ___________________________________

____

11. What task was hardest for your unit? ____

____

12. What task was easiest for your unit? ____

____

13. How did this simulation exercise help you or your unit?

____

____

____

14. How did this simulation exercise waste time for you or your unit?

____

____

____

15. Do you have any suggestions for improving the convoy training?

____

____

____

16. Provide any other comments or suggestions that you may have.

Comment1: ____

____

Comment1: ____

____

Comment1: ____

____

Comment1: ____

____

Comment1: ____

____

Thank you for volunteering to participate in this study.

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APPENDIX O. POST-TRAINING SURVEY (EXPERIMENT 4 CONTROL)

1. Circle your role in the exercise: DRIVER GUNNER VEHICLE COMMANDER (circle one)
If you were a unit commander, what was your billet?____________________________________
2. Rate your knowledge of the following small unit convoy tactics, techniques, and procedures by marking an X in one block for each:

NOT AT ALL PROFICIENT **VERY PROFICIENT**

	1	2	3	4	5
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					

3. Rate the effectiveness of this training exercise in improving your unit's performance by marking an X in one block for each skill:

NOT AT ALL EFFECTIVE **VERY EFFECTIVE**

	1	2	3	4	5
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					

4. What task was hardest for you? ____

____

5. What task was easiest for you? ____

____

6. What task was hardest for your vehicle crew? __________________________________

____

7. What task was easiest for your vehicle crew? __________________________________

____

8. What task was hardest for your unit? ____

____

9. What task was easiest for your unit? ____

____

10. How did this training exercise help you or your unit?

____

____

____

11. How did this training exercise waste time for you or your unit?

____

____

____

12. Do you have any suggestions for improving the convoy training?

____

____

____

13. Provide any other comments or suggestions that you may have.

Comment1: ____

____

Comment1: ____

____

Comment1: ____

____

Comment1: ____

____

Comment1: ____

____

Thank you for volunteering to participate in this study.

APPENDIX P. KNOWLEDGE TEST 1 (EXPERIMENTS 3 - 4)

1. **B** For an unblocked ambush, a vehicle in the kill zone should
   a. Find cover
   b. Continue to move
   c. Stop
   d. Assault

2. **B** Which of the following is not a difference between short and long security halts?
   a. Amount of dismounted support employed
   b. Manning crew vehicle crew served weapons
   c. Amount of cover employed by dismounts
   d. Vulnerability of main body

3. **D** Which action sequence best describes reaction to a sniper?
   a. Security element provides support by fire while main body presses through the kill zone
   b. Security element provides support by fire while main body assaults
   c. Main body provides support by fire while security element assaults
   d. Vehicles return suppressive fire, speed up, and keep moving

4. **C** Who is an appropriate person to conduct IED reporting?
   a. Convoy commander
   b. Gunner of the vehicle who spotted the IED
   c. Assistant convoy commander
   d. Security element commander

5. **A** Which part of the convoy typically handles navigation?
   a. Head
   b. Security
   c. Combat Assault
   d. Main body

6. **A** When analyzing the mission, the convoy commander should follow which process?
   a. Mission, Enemy, Terrain and weather, Troops and fire support, Time (METT-T)
   b. Obstacles, Key terrain, Observation and fields of fire, Cover and concealment, Avenues of approach (OKOCA)
   c. Defend, Reinforce, Assault, Withdraw, Delay (DRAW-D)
   d. Confirm, Clear, Cordon, Check, Control (5 C's)

7. **D** The last step in reacting to an IED is:
   a. Cordon
   b. Report the IED to higher headquarters
   c. Consolidate
   d. Control

8. **D** Where in the convoy should the convoy commander place himself?
   a. Lead vehicle
   b. Trail vehicle
   c. With the security element commander
   d. Main body

9. **B** Which is one of the three elements of a convoy task organization?
   a. Trail
   b. Security
   c. Main body
   d. Head

10. **A** Which is the first step in the recovery of a disabled vehicle?
   a. Establish local security at the vehicle site
   b. Report to higher headquarters
   c. Convoy continues past the vehicle
   d. Nearest vehicle rigs for tow with strap, chain, cable, or tow bar

11. **B** In order to maintain flexibility in the face of a potential threat, a convoy commander should:
   a. Focus on speed and momentum throughout the convoy
   b. Plan an alternate route
   c. Place himself in the lead of the convoy
   d. Place himself in the trail of the convoy

12. **C** Who supervises recovery operations for the convoy?
   a. Vehicle commander
   b. Convoy commander
   c. Assistant convoy commander
   d. Security force commander

13. **D** Who controls the employment of direct and indirect fire assets for the convoy?
   a. Vehicle commander
   b. Convoy commander
   c. Assistant convoy commander
   d. Security force commander

14. **C** Which is not one of the “5 C’s”?
   a. Cordon
   b. Control
   c. Cover
   d. Clear

15. **A** When a convoy reacts to an unblocked ambush, the most critical information to pass to the convoy commander is:
   a. Direction of enemy fires
   b. Speed of the lead vehicle
   c. Nearest checkpoint to the lead vehicle
   d. Number of vehicles taking fire

16. **A** Which is an appropriate range for the vehicle interval in general open terrain?
   a. 50 – 100 meters
   b. 20 – 50 meters
   c. 100 – 150 meters
   d. 150 – 200 meters

17. **C** When crossing a danger area, what should happen after the trail element punches up from the rear to provide over watch?
   a. Convoy resumes normal speed
   b. Main body crosses the danger area
   c. Head crosses the danger area
   d. Head provides over watch on the near side

18. **D** For a blocked ambush, a vehicle that has not yet entered the kill zone should
   a. Assault
   b. Continue to move
   c. Speed up
   d. Find cover

APPENDIX Q. KNOWLEDGE TEST 2 (EXPERIMENTS 3 - 4)

1. **C** Which of the following should not be done at a short security halt?
    a. Conduct “5 and 25” meter checks
    b. Maintain 360 degree security
    c. Dismounts establish a secure perimeter
    d. Man crew served weapons
2. **B** Who maintains communication with higher and adjacent authorities for the convoy?
    a. Vehicle commander
    b. Convoy commander
    c. Assistant convoy commander
    d. Security force commander
3. **C** Which is one of the three organizational elements of a convoy?
    a. Security element
    b. Obstacle Clearing Detachment
    c. Trail
    d. Assault force
4. **B** When crossing a danger area, which element provides over watch while the main body crosses?
    a. Head
    b. Trail
    c. Main body’s security elements
    d. Combat Assault Element
5. **A** Which of the following is not a difference in reaction between blocked and unblocked ambushes?
    a. Whether escort vehicles maneuver to put supporting fires on the enemy
    b. Whether vehicles in the kill zone get out
    c. Whether trail elements stop and seek cover
    d. Whether an alternate route is considered
6. **B** The primary mission of a convoy is:
    a. Route clearance
    b. Moving personnel and / or cargo
    c. Intelligence collection
    d. Destroying enemy combatants
7. **D** When reacting to an IED, the convoy commander should follow which process?
    a. Mission, Enemy, Terrain and weather, Troops and fire support, Time (METT-T)
    b. Obstacles, Key terrain, Observation and fields of fire, Cover and concealment, Avenues of approach (OKOCA)
    c. Defend, Reinforce, Assault, Withdraw, Delay (DRAW-D)
    d. Confirm, Clear, Call, Cordon, Control (5 C’s)
8. **B** Which of the following should not be used to determine convoy speed?
    a. Terrain
    b. Need for crew rest
    c. Weather conditions
    d. Likelihood of enemy contact
9. **A** Which action should the convoy commander avoid when reacting to a sniper?
    a. Stop
    b. Speed up
    c. Return fire
    d. Use smoke

10. **A** Higher headquarters maintains situational awareness of the convoy by monitoring the following control measure:

a. Checkpoints
b. Rally points
c. Coordination points
d. Waypoints

11. **D** If there is only one combat life saver, where in the convoy should he be placed?

a. With the convoy commander
b. In one of the lead vehicles
c. In one of the main body vehicles
d. In one of the trail vehicles

12. **C** Who is an appropriate person to conduct casualty reporting?

a. Combat life saver
b. Corpsman
c. Assistant convoy commander
d. Security element commander

13. **D** When a convoy vehicle first becomes disabled, the security element commander should consider:

a. Providing local security at the vehicle site
b. Punching forward to determine whether enemy are waiting to ambush
c. Ensuring the convoy stops in a herringbone in case of air attack
d. Providing security for the convoy main body

14. **C** For an unblocked ambush, the element that assaults from outside the kill zone is the

a. Trail
b. Main body
c. Security
d. Armored escort

15. **D** The first step in reacting to an IED is:

e. Cordon
f. Report the IED to higher headquarters
g. Call EOD
h. Confirm

16. **D** Which part of the convoy typically sets the pace?

a. Head
b. Security
c. Combat Assault
d. Main body

17. **A** Which is not a responsibility of the vehicle commander?

a. Observe sectors of fire
b. Provide direction to the driver
c. Communicate with the convoy commander
d. Designate sectors of observation

18. **B** It would be inappropriate to speed up for which immediate action drill?

a. Reaction to sniper
b. Reaction to unexploded IED
c. Reaction to unblocked ambush
d. All of the above

APPENDIX R. OPORD SHELL (EXPERIMENT 4)

Scenario: Combat Convoy

Common Skill: Convoy Operations
Unit Level: Platoon

Condition: The platoon has received a fragmentary order (FRAGO) to conduct a combat patrol through the designated AO in order to deny the enemy the ability to interfere with Coalition vehicular traffic in the AO. All necessary personnel and equipment are available. The company has been provided guidance on the rules of engagement (ROE) and / or rules of interaction (ROI) per unit SOP.

Standard: The platoon conducts in accordance with tactical standing operating procedures (TSOP), the order, and / or higher commander's guidance. The platoon complies with the ROE and or ROI.

Scenario Mission Order

OPORD #1

Copy__of__copies

X Bn, X MARINES
XXXXXXU XXX

XXXX

Message Ref

Number-1

MOVEMENT ORDER (1) (COMBAT PATROL)

BASIC ORDER
Ref: (a) Map: Provided

Time Zone: U

Task Organization: No change.

I. SITUATION
A. Terrain and Weather.
29 PALMS: Terrain favors the defender. The terrain provides excellent observation and fields of fire throughout the zone allowing defending forces to mass fires at nearly all locations. The lack of cover and concealment at most points enhances this capability. Additionally, attacking forces are required to move through severely restrictive terrain at several points in the zone.
SAHRANI: Terrain favors the defender. The restrictive terrain canalizes vehicle movement, while high ground provides excellent observation and fields of fire. Wooded areas provide good concealment. The terrain is suitable for small unit harassing activity.

1. Obstacles. Canalizing mountain ranges per map provided.

2. Avenues of approach. See map provided.

3. Key terrain. See map provided.

4. Observation and fields of fire. See map provided.

5. Cover and concealment. See map provided.

6. Weather. Weather favors the attacker. With clear skies, friendly forces have the ability to observe and designate targets throughout the zone, thus supporting the employment of artillery, mortars, and fixed- and rotary-wing close air support. Prevailing winds favor the use of smoke by attacking forces. There is little to no precipitation expected. Humidity is extremely low, and temperatures vary from as low as 40 degrees during the night to as high as 110 or more during the day.

B. Enemy Forces

1. Overview: Combat patrols throughout the Coalition/Joint Operating Area continue to be targeted by insurgents. Administrative and logistical constraints continue to force many combat patrols to travel along predictable routes though not all routes are experiencing attacks. Virtually all combat patrols must be considered possible targets for insurgents. Smaller combat patrols are particularly vulnerable. As insurgent experience grows, the MARFOR warns of increased frequency, efficiency, and sophistication of attacks. At present, roughly 5% of all combat patrols are experiencing some type of attack with 27 Coalition service members KIA in the last 60 days. Historically, during relief-in-place operations, attacks have increased in frequency and lethality.

The insurgents continue to strike primarily at night, using spotters with cell phones to alert attackers of approaching combat patrols. However, in recent weeks due to insurgent success they are becoming increasingly brazen with more attacks occurring during daylight hours. The pace of insurgent attacks is likely to increase in the next few months as the Coalition prepares to conduct RIP operations.

2. The enemy composition has been sporadic in the recent past, ranging from single shooters to platoon sized elements executing complex attacks, integrating direct and indirect fires with victim actuated, radio controlled, and hard-wire command detonated IEDs and/or obstacles. The enemy also typically uses secondary IEDs in conjunction with a primary IED attack IOT target first responders and security forces. The enemy typically uses red or bright pink detonation cord to prime shots, and white or copper firing wire to detonate hard-wired IEDs. The enemy has indirect capability with 82mm (range 3000m) and 120mm mortars (range 5700m); the mortars have been used primarily for harassing fires but have been effectively integrated into complex attacks. The enemy has emplaced multiple AT mines along the MSRs and secondary roads but does not have the engineering capability to lay a traditional minefield. The mines have consisted of AT mines; the AT mines have been used in a double-stack and pressure accumulation configurations in a 100 m (or less) stretch of road.

3. Enemy’s most probable course of action:

a. Observation: Enemy forces have the capability to observe coalition forces upon crossing LD and will be able to provide advance warning due to their spotters using long range cell phones.

b. Indirect: Enemy fires will consist of harassing fires from 82mm and 120mm mortars with possible 122mm rocket fire. The enemy will use their indirect fires to cover their emplaced mines and obstacles IOT disrupt coalition formations and to prevent CF from successfully breaching obstacles.

c. Direct: Enemy will employ direct fire with a variety of weapons including AK47s (max eff range- 200-300m), RPKs (800m), FN MAG 7.62 (1200m) and RPG-7s (moving tgt-300m/stat tgt-500m). Enemy direct fire engagements will range from single shooters to integration of direct fires with IDF/IEDs/mines and obstacles in a complex attack/blocked ambush.

d. Obstacles: Enemy obstacles will most likely consist of deliberately emplaced IEDs made with varying types of explosives and military ordnance. The enemy has been known to initiate IEDs via radio controlled, hard wired, and victim actuated methods. Mines are also routinely used to harass CF and inflict CF casualties. Two to four mines are typically placed on the road and shoulders in a 50 to 100 m stretch of road. The enemy in this area typically uses TM57 and/or TM62 AT mines. The most common wire used for hard wired IEDs is thin copper wire or white lamp cord. Detonation cord is typically red.

e. Chemical: The enemy has detonated (1) chlorine enhanced IED with in the last 30 days.

f. Air: Enemy has no attack aviation capability.

g. Reserve: The enemy has little or no capability to employ a reserve and will withdraw to another ambush site or attempt to blend in with the civilian populace.

h. Electronic: The enemy has limited EW capability; they have the capability of eavesdropping and jamming commercial (i.e. Motorola) radios operating on unsecure nets.

4. Enemy most dangerous course of action: The enemy will conduct a complex attack integrating multiple IEDs or mines to disrupt the CF combat patrol, employing both indirect and direct fire capabilities to piecemeal the CF patrol.

C. Friendly Forces

1. Higher: See Annex J

2. Adjacent: See Annex J

3. Attachments and Detachments: See Annex A

4. Legal Considerations: See Annex J

II. MISSION. On order, X Company, Y Battalion, Z Marines conducts combat patrols through the designated AO to destroy enemy forces in zone in order to deny the enemy the ability to interfere with Coalition vehicular traffic in the AO.

III. EXECUTION

A. Commander’s Intent and Concept of Operation

1. Commander’s Intent. The purpose of this operation is to gain contact with enemy forces and destroy them in order to create conditions

for the enemy that make their efforts to interfere with Coalition operations too risky to be worth their while. The method we will use is a series of properly coordinated, “hardened” combat patrols designed to maximize protection to troops and vehicles; make an unattractive target to insurgents; pose as a deterrent force to current and prospective insurgents; and, where possible, attrite insurgent forces. The desired end state is significant attrition of anti-coalition forces that limits their ability to recruit new fighters, and relative freedom of movement along key MSRs for Coalition forces.

2. Concept of the operation: See Annex C (Operations). This operation will consist of three phases. Phase I is the assembly area phase and consists of vehicle and personnel preparation, the orders process, and pre-combat checks and inspections. Phase II is the movement phase and consists of the actual combat patrol movement along the designated route. Phase III is the reconstitution phase. Phase III is on-order and consists of Class III and V re-supply and follow-on movement.

B. Tasks

1. Patrol Leader

a. At DDTTTTU MMM YY, conduct a combat patrol in the designated AO IOT deny the enemy the ability to disrupt coalition activities in sector.

b. The convoy will consist of no more than 8 firing vehicles.

c. Task the Assistant Patrol Leader and subordinate element leaders as necessary.

d. Coordinate movement during Phase II with X Battalion, X Marines COC.

e. Designate command, control, and communications assignments and techniques that will be employed to carry out the move.

f. Properly integrate attachments.

g. Execute necessary orders, rehearsals, pre-combat checks, and inspections.

h. Complete Convoy After Action Report per SOP.

2. Assistant Patrol Leader

a. At DDTTTTU MMM YY, assist in the conduct of a combat patrol in the designated AO IOT deny the enemy the ability to disrupt coalition activities in sector.

b. Supervise marshalling activities in the Assembly Area.

c. Supervise rehearsals, pre-combat checks, and inspections.

d. Supervise SOP reiteration and enforcement.

e. Supervise enroute maintenance and accountability.

C. Coordinating Instructions: See Annex C Appendix 18 (Operations Overlay)

1. Rank X. X. XXXXXX is designated convoy commander.

2. Designated elements OPCON to convoy commander NLT 24 hours prior to execution.

3. Convoy task organization will terminate on order.

4. MOPP Level 0 in effect.

5. COMBAT PATROL ASSEMBLY AREA: designated per map provided

IV. ADMINISTRATION & LOGISTICS

A. Administration. Additional Control Measures: Used to organize and report combat patrol movement and position:

CP GRID LOCAL DESIGNATION

See scenario map.

B. Logistics

1. MREs issued as required.

2. Ammunition staged in Assembly Area; issued per combat patrol Commander’s guidance.

3. CASEVAC support provided by DET-XX.

4. Patrols and convoys will tow all damaged vehicles to the release point.

V. COMMAND AND SIGNAL

A. Command Relationships. Per Battalion SOP.

B. Command Posts and Headquarters. Located at Camp Wilson.

C. Signal. Per SOP.

ACKNOWLEDGE RECEIPT

R. F. DAGGER
COL, USMC
COMMANDING

ANNEXES:
None.
OFFICIAL:
s/
C. J. SABER
LTCOL, USMC

OPERATIONS OFFICER

APPENDIX S. LIVE CONVOY EVALUATION (EXPERIMENT 4)

MOTORIZED PATROL CHECKLIST

CO.______ PLT.________ SEC.__________ DATE__________ TIME__________
PATROL LEADER-_______________________________ #VICS/PAX________________

1. **Prior to DFL**
   - ☐ WarnO issued? ______________________________
   - ☐ FragO issued? ______________________________
   - ☐ Final coordination and intelligence brief ______________
   - ☐ PCC/PCCI ______________________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

   - ☐ Mission card submitted ______________________________
   - ☐ ______________________________

2. **Depart Friendly Lines**
   - ☐ Short count ______________________________
   - ☐ Comm check, move to AA ______________________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

   - ☐ Dismount & Condition 4 ______________________________
   - ☐ Check out w/ COC ______________________________
   - ☐ ______________________________

3. **Patrol Movement**
   - ☐ Navigator designated/employed? ______________________
   - ☐ PL positioned for best C2? ______________________
   - ☐ Lead trace reporting for turns or direction changes ______________
   - ☐ Use of Vehicle Control Measures ______________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

   - ☐ Dispersion and speed appropriate to METT ______________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

   - ☐ Use of checkpoints/HHQ reporting ______________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

   - ☐ ______________________________

4. **Immediate Actions**

   a. *Short Security Halt*
   - ☐ Duration per SOP? ______________________________
   - ☐ Fire/observation sectors covered? ______________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

   - ☐ ______________________________

b. *Long Security Halt*

☐ Position improvement ____

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Security established ____

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ ____

c. *PIED spotted*

☐ Brevity code used? ____

☐ Sweep/search techniques viable? __________________________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ ____

d. *IED found*

☐ Confirm ____

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Cordon ____

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Control ____

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Call ____

☐ Clear ____

☐ ____

e. *Vehicle Recovery*

☐ Rehearsal evident? ____

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Recovery vehicle designated _______________________________________

☐ Equipment available ____

☐ Obscuration/deception used? ______________________________________

☐ ____

f. *Casualty Evacuation*

☐ Rehearsal evident? ____________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Aid and litter teams or vehicles ____________________

☐ HHQ reporting ____________________

☐ Triage and mission impact ____________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Handling of civilians ____________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ ____________________

g. *Actions on Contact*

☐ PID of targets ____________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Sectors of fire ____________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Fire discipline ____________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Rehearsed response? ____________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Individual actions support PL SOM ____________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Vehicle-dismount integration ____________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ CSW fire support shifted and/or ceased ____________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Consolidation on objective ____________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Pursuit and continuing actions ____________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

1. Reporting to HHQ
2. Casualties
3. Detainees
4. Impact on civil populace
5. Accountability
6. Redistribution/recovery

5. Vehicle Control Points

a. *Snap VCP*

☐ Short halt security ______________________________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Proper vehicle search ______________________________________

☐ Proper personnel search ____________________________________

☐ Use of interpreter or HN forces _____________________________

☐ ____

b. *Hasty VCP*

☐ Long halt security _______________________________________

☐ Rehearsal evident? _______________________________________

☐ Barrier plan effective ____________________________________

☐ Fields of fire acceptable __________________________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ Equipment/signage employed _______________________________

☐ Trigger points established _________________________________

☐ Force continuum understood _______________________________

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

☐ HHQ reporting ____

☐ Personnel search techniques _______________________________

☐ Vehicle search techniques _________________________________

☐ Intelligence collection ____________________________________

☐ Use of interpreter or HN forces _____________________________

☐ Basic Arabic commands used? ______________________________

☐ ____

c. *Deliberate VCP*

i. Not employed

6. Re-entering Friendly Lines

☐ Request made before reaching gate ___________________________

☐ VIC/PAX count modified, if needed __________________________

☐ Dismount and go Condition 4 ______________________________

☐ Conduct AAR ____

☐ Detainee procedures ____________________________________

☐ Prepare for next patrol __________________________________

Additional Comments:____

____

____

____

APPENDIX T. STUDENT DEMOGRAPHIC SURVEY (EXPERIMENT 5)

Please fill in the following questionnaire. All information will be held confidential.

1. Were you required to use computer-based simulations as part of your training in the past?

    NO / **YES** (circle one)

If **YES**, what simulations have you used, and what skills were they used to train (for example, first-person shooter, flight simulator, operational tactics, etc.)?________________________________

____

____

2. Do you have experience playing commercial video games?

    NO / **YES** (circle one)

If **YES**, what games have you played, and what kind of games were they (for example, first-person shooter, flight simulation, sports, fantasy, etc.)?__________________________________

____

____

If **YES**, how often do you use video games?

    Approximately _______ hours per day / week / month / year (circle one)

3. Do you own a personal computer?

    NO / **YES** (circle one)

4. How often do you use a computer <u>off duty</u>?

    Approximately _______ hours per day / week / month / year (circle one)

5. How often do you use a computer <u>on duty</u>?

    Approximately _______ hours per day / week / month / year (circle one)

6. What hand do you use to operate a computer mouse?

    LEFT / **RIGHT** / **EITHER** (circle one)

7. How often do you use the following computer applications? (please answer all that apply)

    a. E-mail: Approximately _______ hours per day / week / month / year (circle one)

    b. Browse web: Approximately _______ hours per day / week / month / year (circle one)

    c. Video: Approximately _______ hours per day / week / month / year (circle one)

    d. Music: Approximately _______ hours per day / week / month / year (circle one)

    e. Word: Processor Approximately _______ hours per day / week / month / year (circle one)

    f. Other: Approximately _______ hours per day / week / month / year (circle one)

8. Year of birth: ____

9. Primary MOS or job specialty: ____

10. Rank: ___________________________________Service: _________________________

11. Time in service: ___________years ___________months **** TURN PAPER OVER**

12. How many times have you deployed to a combat theater?____________________________

13. If you deployed to a combat theater, did you ever participate in convoy operations as a driver, assistant driver, or vehicle gunner?

NO / **YES** (circle one)

If **YES**, approximately how many?____

14. How long have you served with your current unit? ___________years ___________months

16. Rate your agreement with the following statements by marking an X in one block for each:

	DISAGREE **1**	**2**	**3**	**4**	**AGREE** **5**
Computer-based simulation is an effective training tool.					
Today's planned computer-based simulation training will improve my ability to conduct convoy operations.					
Today's planned computer-based simulation training will improve my unit's ability to conduct convoy operations.					
I think a unit should use computer-based simulation in its tactical training.					

17. Write the number of times you have used a sand table or computer-based simulation for each of the following and mark your preference:

	# Sand Table	**# Simulation**	**Preference (circle one)**
Training			Sand table / Simulation
Mission Planning			Sand table / Simulation
Mission Briefing			Sand table / Simulation
Mission Rehearsal			Sand table / Simulation

18. Rate your knowledge of the following small unit convoy tactics, techniques, and procedures by marking an X in one block for each skill:

	NOT AT ALL PROFICIENT 1	2	3	4	VERY PROFICIENT 5
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					
Execute the troop leading steps using BAMCIS					
Conduct mission analysis using METT-T					
Receive a 5 paragraph operational order					
Give a 5 paragraph operational order					

19. Rate your unit's knowledge of the following small unit convoy tactics, techniques, and procedures by marking an X in one block for each skill:

	NOT AT ALL EFFECTIVE 1	2	3	4	VERY EFFECTIVE 5
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					

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APPENDIX U. INSTRUCTOR DEMOGRAPHIC SURVEY (EXPERIMENT 5)

Please fill in the following questionnaire. All information will be held confidential.

1. Were you required to use computer-based simulations as part of your training in the past?

    NO / **YES** (circle one)

If **YES**, what simulations have you used, and what skills were they used to train (for example, first-person shooter, flight simulator, operational tactics, etc.)?________________________________

____

____

2. Do you have experience playing commercial video games?

    NO / **YES** (circle one)

If **YES**, what games have you played, and what kind of games were they (for example, first-person shooter, flight simulation, sports, fantasy, etc.)?__________________________________

____

____

If **YES**, how often do you use video games?

    Approximately _______ hours per day / week / month / year (circle one)

3. Do you own a personal computer?

    NO / **YES** (circle one)

4. How often do you use a computer <u>off duty</u>?

    Approximately _______ hours per day / week / month / year (circle one)

5. How often do you use a computer <u>on duty</u>?

    Approximately _______ hours per day / week / month / year (circle one)

6. What hand do you use to operate a computer mouse?

    LEFT / **RIGHT** / **EITHER** (circle one)

7. How often do you use the following computer applications? (please answer all that apply)

    a. E-mail: Approximately _______ hours per day / week / month / year (circle one)

    b. Browse web: Approximately _______ hours per day / week / month / year (circle one)

    c. Video: Approximately _______ hours per day / week / month / year (circle one)

    d. Music: Approximately _______ hours per day / week / month / year (circle one)

    e. Word: Processor Approximately _______ hours per day / week / month / year (circle one)

    f. Other: Approximately _______ hours per day / week / month / year (circle one)

8. Year of birth: ____

9. Primary MOS or job specialty: ____

10. Rank: ____________________________________Service: _________________________

11. Time in service: ___________years ___________months **** TURN PAPER OVER**

12. How many times have you deployed to a combat theater?____________________________

13. If you deployed to a combat theater, did you ever participate in convoy operations as a driver, assistant driver, or vehicle gunner?

NO / **YES** (circle one)

If **YES**, approximately how many?____

14. How long have you served with your current unit? ___________years ___________months

16. Rate your agreement with the following statements by marking an X in one block for each:

	DISAGREE 1	2	3	4	AGREE 5
Computer-based simulation is an effective training tool.					
Computer-based simulation training will enable me to train my Marines better than if I did not have it.					
I think a unit should use computer-based simulation in its tactical training.					

17. Write the number of times you have used a sand table or computer-based simulation for each of the following and mark your preference:

	# Sand Table	**# Simulation**	**Preference (circle one)**
Training			Sand table / Simulation
Mission Planning			Sand table / Simulation
Mission Briefing			Sand table / Simulation
Mission Rehearsal			Sand table / Simulation

18. Rate how effective you anticipate *VBS 2*™ to be in training each of the following small unit convoy tactics, techniques, and procedures by marking an X in one block for each skill:

	NOT AT ALL EFFECTIVE				VERY EFFECTIVE
	1	**2**	**3**	**4**	**5**
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					
Execute the troop leading steps using BAMCIS					
Conduct mission analysis using METT-T					
Receive a 5 paragraph operational order					
Give a 5 paragraph operational order					

19. Rate your proficiency for each of the following trainer skills with *VBS 2*™:

	NOT AT ALL PROFICIENT				VERY PROFICICENT
Set up the network and computer hardware	**1**	**2**	**3**	**4**	**5**
Set up *VBS 2*™ for Administrator and User					
Start a scenario that has already been built					
Add entities to a scenario					
Use triggers					
Control civilians and traffic					
Control enemy					
Maintain your situational awareness as the trainer					
Set up CNR Sim and CNR Log					
Use an AAR to facilitate a debrief					
Answer user's questions about how to use *VBS 2*™					
Facilitate a call for fire					
Use the simulation to meet your training objectives					

20. As a trainer, what training objective or skill do you think *VBS 2*™ will help you the **most** to train your Marines?____

21. As a trainer, what training objective or skill do you think *VBS 2*™ will help you the **least** to train your Marines?____

22. How would you improve this train-the-trainer instructional package?____________________

APPENDIX V. INSTRUCTOR TRAINING NOTES (EXPERIMENT 5)

- Setting up the DVTE suite's hardware
  - Setting up computers
  - Connecting the LAN
- Disseminate appropriate files to all user computers
  - Administrator
    - Go to Windows Explorer
    - Click on appropriate file
    - Go to File-Properties and then the "Sharing" tab
    - Under "Network sharing and security" check the "Share this folder on the network" box
  - User
    - Go to Tools-Map Network Drive, click browse
    - The shared folder should show up; click on it, and click finish
- Learning to be a *VBS 2* user
  - Introduction brief
  - Cheat Sheet
  - Familiarity scenario
  - Training scenarios
  - Library
- CNR
  - Documentation and access through All Programs→Bohemia Interactive→CNR
  - Setting up CNR Log
    - Configuration-Remote Access→Check "Remote Access Enabled"
    - Ensure Access Port is 8080
    - Leave open
  - Set up VBS LVC
    - Open Notepad
    - Open c:\Program Files\Bohemia Interactive\VBS2 VTK\config\VBSClient.config
    - Get computer IP address
      - Control Panel-Network Connections-Local Area Connection-Support tab
    - Change IP address in VBSClient.config to server computer
  - Start CNR Sim on client computers
    - Set up channels, frequencies, and hot keys
  - Start server computer *VBS 2* using batch file in source directory
    - c:\Program Files\Bohemia Interactive\VBS2 VTK\VBS2 LVC Game CNR Log.bat
  - Start client computers in normal *VBS 2*
  - CNR Log must be on for AAR function to work
- Show location of manuals
  - Go to c:\Program Files\Bohemia Interactive\VBS2 VTK\docs
- Run Training Wheels
  - Use of overhead view
- Setting up the options
  - File is My Documents\VBS2\Administrator VBS2PROFILE file
  - Video Options
    - Terrain Distance: change to 10,000
    - Resolution: 1280 x 1024 x 32
    - Advanced tab: Object Distance: 10,000
  - Controls
    - Up: Delete "Page Up"
    - Go Prone: Delete "Page Down"
    - Map and Hide Map: Delete "M" and replace with "Right CTRL M"

        - GPS and GPS Toggle: “M” and “2 x M”
        - Voice over net and Push to talk: Delete “Caps Lock”
        - Talk on Vehicle channel: “Caps Lock”
- Building a scenario
    - Entering as Administrator (Administrator, DVTEM90build2)
    - “File” options
    - “View” options
    - Map manipulation: zoom and slide
    - Adding a unit
        - Add a server, civilian or blue
        - Naming, Rank, Make Player
        - Review your work
        - Add an enemy player
        - Moving and turning units
        - Deleting a unit
    - Add a group
        - Add an enemy fire team
    - Add a vehicle
        - Unmanned Vehicles—MQ-1 Predator (USAF)
    - Add an empty vehicle
        - Give yourself a HMMWV
    - Measure distance tool
        - Add a measure distance point, right click, new distance
    - Add a waypoint
        - Add a waypoint, and then add more to make a circular path
        - For the last waypoint in the circle, cross
            - Edit the waypoint and change “MOVE” to “CYCLE”
    - Add a vehicle→Ground control station
    - Add a control link
        - Right click and “Link to vehicle” and then click on Ground control station to link
        - Player walks up to the ground control station and treats like vehicle (“U” to interact, then scroll to UAV controller)
    - Add a marker (useful for 2D view)
    - Intel: change the weather and time
    - Add an IED
    - Add a trigger
        - IED
        - Artillery strike
        - Unit / vehicle movement
- Use of AAR tool to debrief an exercise scenario
- Serving as controller for an exercise scenario
    - Artillery
    - Civilians
    - Traffic
    - Use of triggers to cause casualties and vehicle breakdown
- Use of indirect fire console
    - Visibility settings
    - Putting the console in a mission
    - Les
    - Running the console
        - Different mission types
        - Initial call for fire
        - Adjustments
        - Fire for effect
    - Using the console in a mission

APPENDIX W. STUDENT POST TRAINING SURVEY (EXPERIMENT 5)

1. Circle your role in the exercise: DRIVER GUNNER VEHICLE COMMANDER (circle one)
If you were a unit commander, what was your billet?_______________________________________

2. Rate your agreement with the following statements by marking an X in one block for each:

	DISAGREE 1	2	3	4	AGREE 5
Computer-based simulation is an effective training tool.					
Today's computer-based simulation training improved my ability to conduct small unit tactical convoy operations.					
Today's computer-based simulation training improved my unit's ability to conduct small unit tactical convoy operations.					
I think a unit should use computer-based simulation in its tactical training.					

3. If you had to choose a single training medium, would you prefer to prepare for a small unit tactical convoy using a sand table or a computer-based simulation?

SAND TABLE / **COMPUTER SIMULATION** (circle one)

4. Rate your knowledge of the following small unit convoy tactics, techniques, and procedures by marking an X in one block for each:

	NOT AT ALL PROFICIENT 1	2	3	4	VERY PROFICIENT 5
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					
Execute the troop leading steps using BAMCIS					
Conduct mission analysis using METT-T					
Receive a 5 paragraph operational order					
Give a 5 paragraph operational order					

5. Rate the effectiveness of this computer simulation exercise in improving your unit's performance by marking an X in one block for each skill:

	NOT AT ALL EFFECTIVE			VERY EFFECTIVE
	1	2	3	4	5
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					

6. Rate your agreement with the following statements by marking an X in one block for each:

	DISAGREE				AGREE
	1	2	3	4	5
This training mission was successful.					
During this exercise, I felt like my actions in the virtual environment had no consequences.					
During this exercise, I felt like I was playing a game.					
During this exercise, I felt like I was conducting training.					
During this exercise, I felt like I was part of the group working together.					
During this exercise, I felt isolated from the others.					
This computer simulation provided sufficient audio cues for me to know what was going on.					
This computer simulation provided sufficient visual cues for me to know what was going on.					
The training value of this exercise came from the debriefing and not the exercise itself.					

7. What task was hardest for you? ______________________________

____

8. What task was easiest for you? ______________________________

____

9. What task was hardest for your vehicle crew? ______________________________

____

10. What task was easiest for your vehicle crew? ______________________________

____

11. What task was hardest for your unit? ______________________________

____

12. What task was easiest for your unit? ______________________________

____

13. How did this simulation exercise help you or your unit?

____

____

____

14. How did this simulation exercise waste time for you or your unit?

____

____

____

15. Do you have any suggestions for improving the convoy training?

____

____

____

16. Provide any other comments or suggestions that you may have.

Comment1: ______________________________

____

Comment1: ______________________________

____

Comment1: ______________________________

____

Comment1: ______________________________

____

Comment1: ______________________________

____

Thank you for volunteering to participate in this study.

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APPENDIX X. INSTRUCTOR POST TRAINING SURVEY (EXPERIMENT 5)

1. Circle your role in the exercise: CONTROLLER ARTILLERY OBSERVER (circle one)

2. Rate your agreement with the following statements by marking an X in one block for each:

	DISAGREE 1	2	3	4	AGREE 5
Computer-based simulation is an effective training tool.					
Computer-based simulation training enabled me to train my Marines better than if I did not have it.					
I think a unit should use computer-based simulation in its tactical training.					

3. If you had to choose a single training medium, would you prefer to prepare for a small unit tactical convoy using a sand table or a computer-based simulation?

SAND TABLE / **COMPUTER SIMULATION** (circle one)

4. Rate how effective you thought *VBS 2*™ was in training each of the following small unit convoy tactics, techniques, and procedures by marking an X in one block for each skill:

	NOT AT ALL EFFECTIVE 1	2	3	4	VERY EFFECTIVE 5
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					
Execute the troop leading steps using BAMCIS					
Conduct mission analysis using METT-T					
Receive a 5 paragraph operational order					
Give a 5 paragraph operational order					

5. Rate which training platform you would prefer to use to train each of the following small unit convoy tactics, techniques, and procedures by marking an X in one block for each skill:

	***VBS 2*™**		**Don't care**		**VCCT**
React to an unexploded Improvised Explosive Device					
React to an Improvised Explosive Device detonation					
Take immediate action against a blocked ambush					
Take immediate action against an unblocked ambush					
Cordon and 360 degree security					
Employ vehicle machine guns / weapons					
Mounted fire and maneuver					
Shift fires / cease fires					
Vehicle recovery / bump plan					
Casualty evacuation					
Communication with higher headquarters					
Communication between vehicles in convoy					
Communication between personnel in vehicle					
Execute the troop leading steps using BAMCIS					
Conduct mission analysis using METT-T					
Receive a 5 paragraph operational order					
Give a 5 paragraph operational order					

6. Rate your proficiency for each of the following trainer skills with *VBS 2*™:

	NOT AT ALL PROFICIENT 1	2	3	4	VERY PROFICIENT 5
Set up the network and computer hardware					
Set up *VBS 2*™ for Administrator and User					
Start a scenario that has already been built					
Add entities to a scenario					
Use triggers					
Control civilians and traffic					
Control enemy					
Maintain your situational awareness as the trainer					
Set up CNR Sim and CNR Log					
Use an AAR to facilitate a debrief					
Answer user's questions about how to use *VBS 2*™					
Facilitate a call for fire					
Use the simulation to meet your training objectives					

7. Rate your agreement with the following statements by marking an X in one block for each:

	DISAGREE 1	2	3	4	AGREE 5
This training was successful.					
During this exercise, I felt like training was not real enough.					
During this exercise, I felt like we were playing a game.					
During this exercise, I felt like we were conducting training.					
This computer simulation provided sufficient audio cues for me to know what was going on.					
This computer simulation provided sufficient visual cues for me to know what was going on.					
The training value of this exercise came from the debriefing and not the exercise itself.					

8. As a trainer, what training objective or skill do you think *VBS 2*™ will help you the **most** to train your Marines?____

9. As a trainer, what training objective or skill do you think *VBS 2*™ will help you the **least** to train your Marines?____

10. How did this simulation exercise help you or your unit?

11. How did this simulation exercise waste time for you or your unit?

12. Do you have any suggestions for improving the simulation training?

13. Provide any other comments or suggestions that you may have.

Comment:

Comment:

Comment:

Comment:

Comment:

Thank you for volunteering to participate in this study.

APPENDIX Y. KNOWLEDGE TEST A (EXPERIMENT 5)

1. **B** For an unblocked ambush, a vehicle in the kill zone should
   e. Find cover
   f. Continue to move
   g. Stop
   h. Assault

IA Procedure
Unblocked ambush—does student understand basic execution?

2. **A** Higher headquarters maintains situational awareness of the convoy by monitoring the following control measure:
   e. Checkpoints
   f. Rally points
   g. Coordination points
   h. Waypoints

Mission planning
Does the student understand basic control measures?

3. **C** Which is not one of the "5 C's"?
   e. Cordon
   f. Control
   g. Cover
   h. Clear

Reporting
Does the student understand basic reporting responsibilities?

4. **A** What are the three main components of the Situation paragraph of the 5 paragraph operational order?
   a. Terrain and weather; enemy situation, friendly situation
   b. Terrain and weather; enemy situation; commander's intent
   c. Mission; concept of operations; commander's intent
   d. Beans; bullets; bandaids

Mission planning
OPORD—Understanding of basic OPORD structure

5. **C** Which of the following should not be done at a short security halt?
   e. Conduct "5 and 25" meter checks
   f. Maintain 360 degree security
   g. Dismounts establish a secure perimeter
   h. Man crew served weapons

IA Procedure
Halts—does student understand difference betw long / short halt?

6. **A** Which is not a responsibility of the vehicle commander?
   e. Observe sectors of fire
   f. Provide direction to the driver
   g. Communicate with the convoy commander
   h. Designate sectors of observation

Responsibilities
Does the student understand basic crew tasks?

7. **C** Who is an appropriate person to conduct IED reporting to higher headquarters?
   e. Vehicle commander of the trail vehicle
   f. Gunner of the vehicle who spotted the IED
   g. Assistant convoy commander
   h. Security element commander

Responsibilities / Division of labor
ACC handles administrative so CC can fight the unit / direct action

8. **D** Which of the following would you consider in the "E" part of METT-T?
   a. Weather and its effects
   b. Terrain and its effects
   c. Composition of friendly forces
   d. Composition of enemy forces

Mission planning
METT-T—Understanding of enemy considerations in mission planning

9. **A** Which is the first step in the recovery of a disabled vehicle?
   e. Establish local security at the vehicle site
   f. Report to higher headquarters
   g. Convoy continues past the vehicle
   h. Nearest vehicle rigs for tow with strap, chain, cable, or tow bar

IA Procedure
Vehicle recover—does student understand basic execution?

10. **C** In the 5 paragraph operational order, in which paragraph would you task your subordinate units?
   a. Paragraph 1
   b. Paragraph 2
   c. Paragraph 3
   d. Paragraph 4

Mission planning
OPORD—Understanding of basic OPORD structure

11. **A** Which part of the convoy typically handles navigation?
   e. Head
   f. Security
   g. Combat Assault
   h. Main body

Organizational structure vs task organization
Does student understand organizational?

12. **B** Which troop leading step allows you to gain information that you need to complete your plan?
   a. Begin planning
   b. Make reconnaissance
   c. Execute the operation
   d. Conduct rehearsals

Mission planning
BAMCIS—Understanding of basic troop leading steps

13. **D** Which action sequence best describes reaction to a sniper?
   e. Security element provides support by fire while main body presses through the kill zone
   f. Security element provides support by fire while main body assaults
   g. Main body provides support by fire while security element assaults
   h. Vehicles return suppressive fire, speed up, and keep moving

IA Procedure
Sniper—does student understand basic execution?

14. **C** When planning an operation, you should take _____ of the time available for yourself and leave ______ of the time available for your subordinates.
   a. 1/2; 1/2
   b. 2/3; 1/3
   c. 1/3; 2/3
   d. 3/4; 1/4

Mission planning
Understanding of basic mission planning fundamentals

15. **C** Which is one of the three organizational elements of a convoy?
   e. Security element
   f. Obstacle Clearing Detachment
   g. Trail
   h. Assault force

Organizational structure vs task organization
Does student understand the difference?

16. **C** If you received a 5 paragraph operational order from your higher headquarters, where would you primarily look to find your mission?
   a. Friendly situation
   b. Commander's intent
   c. Tasks to subordinate units
   d. Coordinating instructions

Mission planning
OPORD—Understanding of basic OPORD structure

17. **C** Who supervises recovery operations for the convoy?
   e. Vehicle commander
   f. Convoy commander
   g. Assistant convoy commander
   h. Security force commander

Responsibilities / Division of labor
Does student understand delegation of logistic functions?

18. **A** When analyzing the mission, the convoy commander should follow which process?
   e. Mission, Enemy, Terrain and weather, Troops and fire support, Time (METT-T)
   f. Obstacles, Key terrain, Observation and fields of fire, Cover and concealment, Avenues of approach (OKOCA)
   g. Defend, Reinforce, Assault, Withdraw, Delay (DRAW-D)
   h. Confirm, Clear, Cordon, Check, Control (5 C's)

Mission Planning
Basic understanding of mission planning concepts

19. **C** For an unblocked ambush, the element that assaults from outside the kill zone is the
   e. Trail
   f. Main body
   g. Security
   h. Armored escort

IA Procedure
Ambush—does student understand basic execution?

20. **A** When a convoy reacts to an unblocked ambush, the most critical information to pass to the convoy commander is:
   e. Direction of enemy fires
   f. Speed of the lead vehicle
   g. Nearest checkpoint to the lead vehicle
   h. Number of vehicles taking fire

IA Procedure
Unblocked ambush—does the student understand basic execution?

21. **D** In what part of the 5 paragraph operational order would you publish the time line for the operation?
   a. Friendly situation
   b. Mission statement
   c. Tasks to subordinate units
   d. Coordinating instructions

Mission planning
OPORD—Understanding of basic OPORD structure

22. **D** The last step in reacting to an IED is:
   i. Cordon
   j. Report the IED to higher headquarters
   k. Consolidate
   l. Control

IA Procedure
IED—does student understand the 5 C's?

23. **B** In the 5 paragraph operational order, in which paragraph would you find the time you should start your mission?
   a. Paragraph 1
   b. Paragraph 2
   c. Paragraph 4
   d. Paragraph 5

Mission planning
OPORD—Understanding of basic OPORD structure

24. **A** Which is an appropriate range for the vehicle interval in general open terrain?
   e. 50 – 100 meters
   f. 20 – 50 meters
   g. 200 – 400 meters
   h. 150 – 250 meters

Movement
Does the student understand basic convoy movement principles?

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APPENDIX Z. KNOWLEDGE TEST B (EXPERIMENT 5)

1. **D** For a blocked ambush, a vehicle that has not yet entered the kill zone should
   a. Assault
   b. Continue to move
   c. Speed up
   d. Find cover

IA Procedure
Unblocked ambush—does student understand basic execution?

2. **B** The primary mission of a convoy is:
   e. Route clearance
   f. Moving personnel and / or cargo
   g. Intelligence collection
   h. Destroying enemy combatants

Mission planning
Does student understand the purpose of convoy?

3. **D** When reacting to an IED, the convoy commander should follow which process?
   e. Mission, Enemy, Terrain and weather, Troops and fire support, Time (METT-T)
   f. 5 / 25's
   g. Defend, Reinforce, Assault, Withdraw, Delay (DRAW-D)
   h. Confirm, Clear, Call, Cordon, Control (5 C's)

IA Procedure
IED—does the student understand the 5 C's?

4. **B** When considering the effects of terrain, which is not one of the standard considerations as described by the acronym OCOKA?
   a. Observation and fields of fire
   b. Orientation
   c. Cover and concealment
   d. Avenues of approach

Mission planning
METT-T—Understanding of terrain analysis steps

5. **B** Which of the following is a way that short and long security halts are the same?
   e. Amount of dismounted support employed
   f. Vehicle crew served weapons are manned and oriented on designated sector of fire
   g. Amount of cover employed by dismounts
   h. Vulnerability of main body

IA Procedure
Halts—crew served weapons must always be employed in security as priority

6. **D** Where in the convoy should the convoy commander place himself?
   e. Lead vehicle
   f. Trail vehicle
   g. With the security element commander
   h. Main body

Responsibilities
Does the student understand CC enough not to be in front IOT maintain control?

7. **C** Who is an appropriate person to conduct casualty reporting?
   e. Combat life saver
   f. Corpsman
   g. Assistant convoy commander
   h. Security element commander

Responsibilities / Division of labor
Does student understand to delegate reporting so CC can fight?

8. **D** Which of the following correctly represents the "T's" in METT-T?
   a. Training, Troops, Time
   b. Terrain, Training, Time
   c. Terrain, Trucks, Time
   d. Terrain, Troops, Time

Mission planning
METT-T—Understanding of basic mission planning steps

9. **D** When a convoy vehicle first becomes disabled, the security element commander should consider the following as his primary responsibility:
   e. Reporting the disabled vehicle to higher headquarters
   f. Punching forward to determine whether enemy are waiting to ambush
   g. Ensuring the convoy stops in a herringbone in case of air attack
   h. Providing security for the convoy main body

IA Procedure
Vehicle rec—does the student understand to maintain convoy security first?

10. **D** In the 5 paragraph operational order, in which paragraph would you find the frequency of the higher command radio net?
   a. Paragraph 2
   b. Paragraph 3
   c. Paragraph 4
   d. Paragraph 5

Mission planning
OPORD—Understanding of basic OPORD structure

11. **D** Who specifies the speed of the convoy?
   e. Lead vehicle commander
   f. Security element commander
   g. Driver of the lead vehicle
   h. Convoy Commander

Responsibilities
Does the student understand that the logistics in main body determines spd?

12. **C** Which of the following is not one of the troop leading steps?
   a. Supervise
   b. Complete the plan
   c. Execute the operation
   d. Begin planning

Mission planning
BAMCIS—Understanding of basic troop leading steps

13. **A** Which action should the convoy commander avoid when reacting to a sniper?
   e. Stop
   f. Speed up
   g. Return fire
   h. Use smoke

IA Procedure
Sniper—does the student understand basic execution?

14. **B** In order to maintain flexibility in the face of a potential threat, a convoy commander should:
   e. Focus on speed and momentum throughout the convoy
   f. Plan an alternate route
   g. Place himself in the lead of the convoy
   h. Place himself in the trail of the convoy

Mission planning
Does the student understand how mission planning affects future execution?

15. **B** Which is one of the three elements of a convoy task organization?
   e. Trail
   f. Security
   g. Main body
   h. Head

Organizational structure vs task organization
Does the student understand task organization?

16. **D** What part of the operational order would you use to ensure your subordinates understood the final end state of the operation?
   a. Concept of operations
   b. Coordinating instructions
   c. Command and signal
   d. Commander's intent

Mission planning
OPORD—Understanding of basic OPORD structure

17. **B** Who maintains communication with higher and adjacent authorities for the convoy?
  e. Vehicle commander
  f. Convoy commander
  g. Assistant convoy commander
  h. Security force commander

Responsibilities / Division of labor
Does student understand to delegate reporting and CC fight?

18. **B** Why would you use METT-T?
  a. Describe the effects of terrain on the operation
  b. Analyze your mission in order to plan the operation
  c. Develop the time line for the operation
  d. Coordinate indirect and direct fire plans for the concept of operations

Mission planning
METT-T—Understanding the purpose of METT-T as an aid to mission planning

19. **B** It would be inappropriate to speed up for which immediate action drill?
  e. Reaction to sniper
  f. Reaction to unexploded IED
  g. Reaction to unblocked ambush
  h. All of the above

IA Procedure
Ambush—does the student understand basic execution?

20. **B** When crossing a danger area, which element provides over watch while the main body crosses?
  e. Obstacle Clearing Detachment
  f. Trail
  g. Main body's security elements
  h. Combat Assault Element

IA Procedure
Danger area—does student understand basic execution

21. **B** Which part of the 5 paragraph operational order paints a word picture of how the operation should unfold?
  a. Terrain and weather
  b. Concept of operations
  c. Friendly situation
  d. Mission

Mission planning
OPORD—Understanding of basic OPORD structure

22. **D** The first step in reacting to an IED is:
  a. Cordon
  b. Report the IED to higher headquarters
  c. Call EOD
  d. Confirm

IA Procedure
IED—does the student understand the 5 C's?

23. **A** In the 5 paragraph operational order, in which paragraph would you find the enemy's most likely course of action?
  a. Paragraph 1
  b. Paragraph 2
  c. Paragraph 3
  d. Paragraph 4

Mission planning
OPORD—Understanding of basic OPORD structure

24. B Which of the following should not be used to determine convoy speed?
  e. Terrain
  f. Need for crew rest
  g. Weather conditions
  h. Likelihood of enemy contact

Movement
Does the student understand basic movement principles?

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